

**CRITIQUING THE MASTERS: APPLYING 3D PRODUCTION LIGHTING
PRINCIPLES TO FAMOUS 2D WORKS OF ART**

A Thesis

by

ANGELIQUE NICOLE FORD

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2012

Major Subject: Visualization

Critiquing the Masters: Applying 3D Production Lighting Principles to Famous 2D

Works of Art

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Approved by:

Chair of Committee,	Carol LaFayette
Committee Members,	Tim McLaughlin
	John Keyser
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ABSTRACT

Critiquing the Masters: Applying 3D Production Lighting Principles to Famous 2D

Works of Art. (August 2012)

Angelique Nicole Ford, B.S., Texas A&M University

Chair of Advisory Committee: Prof. Carol LaFayette

This thesis demonstrates the effects of applying lighting principles developed for 3D computer graphics production to well-known historical 2D paintings. The visual analysis and cinematographic direction is derived from the iterative review-critique-review process used in production of 3D animated films and the imposition of a narrative purpose for re-lighting. This thesis focuses on five of the important fundamentals of lighting design, adapted and defined by Pixar Animation Studios Director of Photography Sharon Calahan in “Storytelling Through Lighting: A Computer Graphics Perspective.” The results are 2D images that are easily recognizable as adaptations from the original paintings, but that communicate a distinctly different visual impression. Each re-lit painting serves as an example of the lighting principle employed and offers a unique viewpoint on a well-known artwork.

For every Vizzer who never thought they would finish.

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NOMENCLATURE

2D	Two-dimensional
3D	Three-dimensional
CG	Computer Graphics
DP	Director of Photography

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CHAPTER I

INTRODUCTION

When a three-dimensional (3D) computer graphics lighting designer sits down in front of a scene completely devoid of light, it is akin to an artist in front of a blank canvas. Light color, placement, intensities, the number of lights, the various moods and illusions that can be created with light; there are literally infinite possibilities with how the scene can come to life when an artist begins to paint with light.

3D lighting is typically used to create imaginary scenes. The lighting styles employed are often inspired by the work of earlier masters of traditional painting. What if we reverse the application and look at the works of early painters through the lens of CG lighting? What if we take what we've learned about critiquing 3D shots and apply that knowledge to paintings created hundreds of years ago? "What if Pierre-Auguste Renoir, Vincent van Gogh, Edgar Degas, Leonardo da Vinci, and Johannes Vermeer all answered to a lighting Director of Photography (DP) who critiqued their work? What might their famous works look like if we reimagined them based on our modern 3D fundamentals of lighting design?"

This thesis follows the style of *IEEE Transactions on Visualization and Computer Graphics*.

I.1 Motivation

As a lighter with six years of experience at a major computer animation studio, it's my job every day to light shots that evoke an emotional response from a viewer during important story points. Shots are a continuous series of images that run for an uninterrupted period of time. When played in motion, the images create animation. In Figure 1, you can see three frames of animation from the Disney/Pixar film *Ratatouille*.



Figure 1. Three individual frames of animation from the Disney/Pixar film *Ratatouille* [9].

Each film has its own Director of Photography (DP). The DP's job is to work with the Director to develop a look for the lighting in a film. The DP also works with the lighting artists on a film. Through a careful shot lighting critique process the DP communicates the Director's vision for the story points in each shot and how the lighting should be used to enhance those story points. Creating the right emotional mood for a particular story point is a challenging task, even when the viewer is seeing the images on-screen for the first time and has no preconceived impression or feelings about the images. Experiencing the shot lighting critique process firsthand has inspired me to

research a thesis which pushes the idea past merely creating a viewer's impression about an image to actually changing a viewer's impression about an image. This change has more of an impact if the viewer has an established history with the image. For this reason, I have chosen to apply this research to famous 2D works of art.

I.2 Organizing an Approach to Lighting Design

To begin narrowing down the possibilities of the lighting design for a scene we must first understand the goals of a lighting designer. In her chapter "Storytelling through Lighting: a Computer Graphics Perspective," in the book *Advanced Renderman*, Sharon Calahan states:

"The primary purpose of cinematic lighting is to support the story by contributing to the overall visual structure of the film. The director is the storyteller, and it is his vision that the lighting designer is attempting to reveal. To that end, it is vital to understand the story point behind each shot and how it relates to the sequence and to the story as a whole. It is not enough that the lighting designer simply illuminate the scene so the viewer can see what is happening, or to make it look pretty. It is the lighting designer's task to captivate the audience by emphasizing the action and enhancing the mood [3]."

Keeping the goal of visual storytelling at the forefront, Sharon discusses an organized approach to cinematic lighting. She adapts five of the important fundamentals of good lighting design from *Matters of Light and Depth* by Ross Lowell [26]. She states them as:

- Directing the viewer's eye
- Creating depth

- Enhancing mood, atmosphere and drama
- Revealing character personality and situation
- Conveying time of day and season

By combining principles of design, fine art, photography, illustration, cinematography, and the psychology of visual perception, Sharon describes how to utilize lighting to appropriately communicate the mood and intention of important story points.

I.3 The Production Lighting Environment

This artist has gained a unique perspective on the production lighting process through her work as a lighting technical director at a major animation studio for the past six years. This experience will help inform the production lighting process throughout this thesis.

An extremely important relationship exists between a lighter and a Director of Photography (DP) in an animated production pipeline. It's a relationship based on trust, guidance, and communication. In very limited times available for review, the DP must convey the intended story point of a shot and the visual goals they would like the lighter to use to communicate the story point. It is the lighter's responsibility to interpret the notes from the DP, use the given tools to accomplish the visual goals, and trust the DP's artistic direction for the film. This happens through a process of notes, application, results, and more notes. The production lighting process can be broken down into the following steps:

- Notes – The Director of Photography analyzes the shot and gives notes.
- Application – The lighter uses the given software tools to achieve the notes.
- Results – The lighter shows the resulting images to the DP.
- The above process repeats until the shot is ready to show to the Director or until the DP approves it.

I.4 Statement of Intent

This artist has researched the five fundamentals of lighting design as stated by Sharon Calahan in “Storytelling Through Lighting: A Computer Graphics Perspective” and used the four steps listed above in the production lighting process to apply the fundamentals in an original way to famous 2D works of art. The intent was to determine the effects of applying the 3D shot lighting critique process and the fundamentals of lighting to well-known historical 2D paintings in an effort to create 2D images that are easily recognizable as adaptations from the original paintings, but that communicate a distinctly different visual impression. Lighting was selected as the focus of this thesis as opposed to other methods of composing 2D artworks because of my experience as a lighter and, in my opinion, because it has the greatest range of emotional impact on the final image. Lighting adjustments can communicate a great range of specific ideas and emotions, making lighting an excellent tool to demonstrate the adaptation of the viewpoint of a 2D artwork.

Research included enhanced understanding of the fundamentals as outlined by Sharon Calahan and discussion of the shot lighting production pipeline as experienced during this artist's years of work as a lighter. The methodology was to apply each of the five fundamentals of good lighting design to a selected 2D work of art in the context of a 3D shot lighting critique. Through the selection of the 2D artworks I was not commenting on the artist's original vision. I took each image out of the context and purpose for which it was originally painted and placed it into the context of a computer graphics lighting production pipeline. Images can be created for many reasons and in many styles independent of a computer graphics pipeline.

After selecting the well-known 2D works of art, the lighting in each piece was digitally adapted in *Adobe Photoshop CS5 version 12.0.4* creating an original 2D viewpoint of the artwork. Each relit 2D artwork is an original adaptation of the work, focusing on one of the fundamentals of good lighting design: directing the viewer's eye; creating depth; enhancing mood, atmosphere, and drama; and conveying time of day and season. An attempt was made to select works that are well known enough that most viewers will already have a familiarity with them, thus increasing the viewer's emotional contrast when the images are seen in a different "light."

Criteria for evaluation was the ability for this artist to successfully convey the intended lighting principle in each image adapting it in such a way that presents a unique viewpoint on the work. Through the digital relighting process changes were allowed to the point that the work demonstrated the intended lighting principle, provided the work remained recognizable as an adaptation of the original artwork upon reasonable viewer

observation. The lighting principles this artist attempted to convey and the selected artworks are listed below.

- Directing the Viewer's Eye - Pierre-Auguste Renoir's *Bal du moulin de la Galette*
- Creating Depth - Vincent van Gogh's *Bedroom in Arles* (3rd Version)
- Enhancing Mood, Atmosphere, and Drama - Edgar Degas' *La Classe de Danse*
- Revealing Character Personality and Situation - Grant Wood's *American Gothic*
- Conveying Time of Day and Season - Johannes Vermeer's *The Astronomer*

CHAPTER II

BACKGROUND

II.1. Directing the Viewer's Eye

Paintings and film frames contain information for the viewer. Some parts of the information are more important than others. If the information isn't presented to the audience in an organized way, important information could be overlooked, resulting in the viewer missing the intent of a work of art or the main point of a scene.

To ensure that the viewer's eye is directed to the intended focal point in the image we use principles of composition. "Through composition we are telling the audience where to look, what to look at and in what order to look at it [4]". Sharon Calahan states, "The primary objective of good lighting is to show the viewer where to look by enhancing what is important while minimizing what isn't. Shots are often on-screen only briefly which means the storytelling effectiveness of a shot often depends upon how well, and how quickly, the viewer's eye is led to the key story elements [3]." In production, camera angles, sets, and animation are all composed to camera by layout artists, set dressers, and animators, respectively. When a lighting designer receives a shot, they have little sway over the compositional elements they are given. This enhances the challenge of a lighter's job because through lighting alone, they must draw the viewer's eye to the focal point of the shot. Figure 2 is an example from *Toy Story 3* of a busy composition. There are several characters and objects in this unlit scene.



Figure 3. Using lighting to organize the image and create a focal point [25].

II.1.1. Unity

To create a successful composition it's important to understand how the various elements of the composition appear to belong together and relate to each other. Unity is the principle that the elements of the composition work together as a whole to create a visually interesting image. "The principle of unity reminds the artist to take a step back and look at the image as a whole [3]."

Most artists have an innate sense of whether a composition is working or not, but as a more objective approach to design philosophy, German cognitive psychologists in

the 1920s developed the Gestalt theory to explain some of our perceptual tendencies [3]. The word gestalt means ‘whole’ or ‘pattern’. These theories try to describe how people tend to visualize elements into groups when certain principles are applied. “Gestaltists emphasize the importance of organization and patterning in enabling the viewer to perceive the whole stimulus rather than discerning it only as discrete parts [10]”. They have developed a set of organizational rules that describe how people perceive the world visually without it being completely overwhelming. These rules include:

- 1) Grouping – This principle states that the brain attempts to group objects close to each other into a larger unit, especially if they share the same size, shape, color or value [10]. For example, in Figure 4 we visually group the circles into columns by similar color or into rows by similar shape.

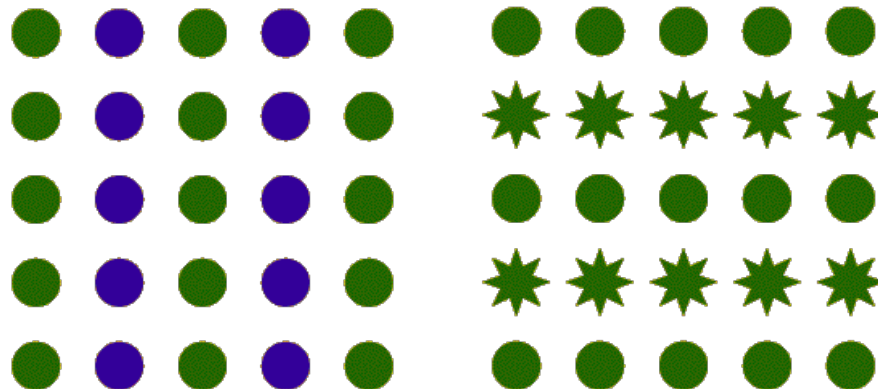


Figure 4. Illustrates the Gestalt principle of grouping by color and by shape [36].

In Figure 5 and Figure 6 below of Merida from the Disney/Pixar film *Brave*, I've demonstrated how our brains create a visual grouping with the characters screen right of Merida and screen left of Merida.



Figure 5. A still from the Disney/Pixar film *Brave* [17].



Figure 6. Demonstrates the Gestalt principle of unity through grouping.

2) Planes – We attempt to divide our world into planes of foreground and background receding in space from our point of view. This quickly enables us to identify objects that are close and objects that are farther away [10]. Danish psychologist Edgar Rubin was one of the first to investigate this theory. When perceiving a visual field, some objects take a prominent role while others recede into the background. This idea is exemplified in the image of the Rubin Face/Vase Illusion in Figure 7. In this image the viewer can either see two profiles move to the foreground with the white moving to the background, or a vase moving to the foreground and the black being pushed to the background. The viewer may even perceive that the image pops between the two views.

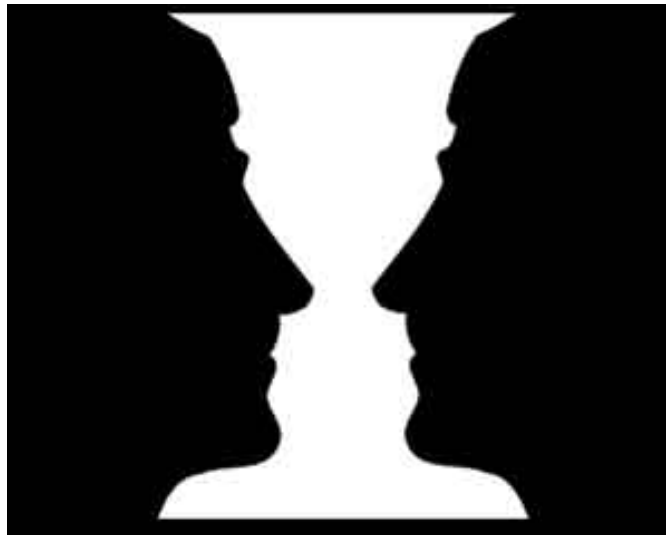


Figure 7. The Rubin Face/Vase Illusion, Edgar Rubin, c. 1915 [32].

In Figure 8, an example from the film *Brave*, we are quickly able to organize the composition into foreground and background elements by applying

the concept of unity through planes. Figure 9 shows how the bear paw can quickly be identified as a foreground object because it is closer to camera. Merida and the rocks are identified as background objects further away from camera.



Figure 8. A still from the Disney/Pixar film *Brave* [17].



Figure 9. Demonstrates the Gestalt principle of unity through planes.

- 3) Continuous Patterns – Our brains want to perceive a finished unit, even if there are gaps in an object [10]. As such, patterns or objects that continue in one direction, even if they are not completely continuous or are missing information will be perceived as being continuous [3]. For example, in Figure 10, we can visually assemble the shapes from the broken line segments [3].

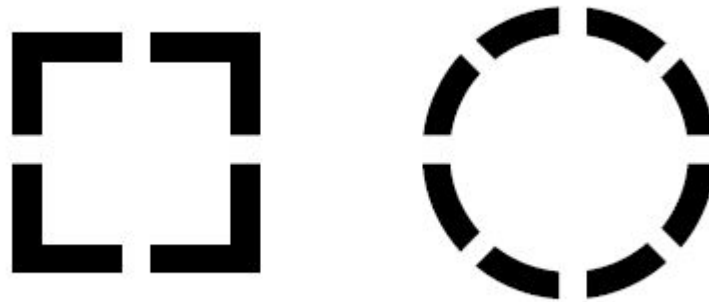


Figure 10. Illustrates the Gestalt Principle of continuous patterns [3].

- 4) Constancy – The brain tends to “interpret the world by comparing objects and deciding if something is the same as or different from something else it sees” [3]. The brain also compares what it sees to objects it’s seen before to look for relationships between objects. “If a person is familiar with an object, he remembers its size, shape, and color and applies that memory when he sees that object in an unfamiliar environment. This helps him to become familiar with the

new environment, instead of becoming disoriented, by relating objects in the new environment to the known object [10].”

The principles of unity are important for artists to grasp because if they are not followed, the artist risks creating an image that is visually disorganized and causes the viewer’s eye to become fatigued and the viewer to lose interest in the image [3]. Additionally, too much unity can be boring to the viewer if there is nothing to visually resolve and the viewer will also lose interest [3]. Through successful light and shadow placement, a lighter can organize an overly busy composition, or add interest to an otherwise uninteresting composition. Making these decisions is part of the beauty and art form of lighting design.

II.1.2. Emphasis

To direct a viewer’s eye to a certain point of an image, the image needs a focal point or point of greatest emphasis. “An image without emphasis is like wallpaper; the eye has no particular place to look and no reward for having tried [3].” In Figure 11, you can see that the image has no point of emphasis and thus the eye wanders around the composition not knowing where to land.

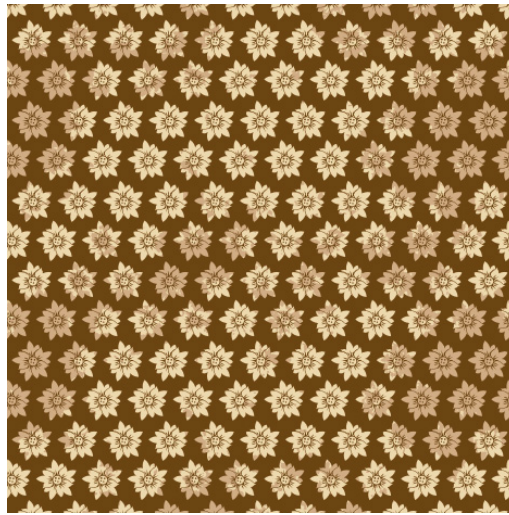


Figure 11. Image with no discernable focal point, the eye wanders around the composition and quickly loses interest.

Points of emphasis are necessary to help the viewer organize the information contained in the image. If we understand what attracts the eye, lighting designers can minimize areas that detract from the focal point and create emphasis on the intended focal point, ensuring that the viewer's eye is drawn to the correct location in an image [10].

II.1.2.1. Contrast

The primary way to create a point of emphasis in an image is by contrast [10]. The eye is drawn to the point of contrast because the difference interrupts the perception of pattern in the scene. The contrast creates visual tension that the eye wants to resolve.

As we discussed in the principle of unity, the brain tries to group similar objects together, if an object differs, it draws the brain's attention to that object and thus grabs the viewer's eye. It could differ by color, shape, size, value, or any attribute that causes it to stand out from the rest of the group. In Figure 12, a point of contrast is introduced in the image, drawing the viewer's eye.

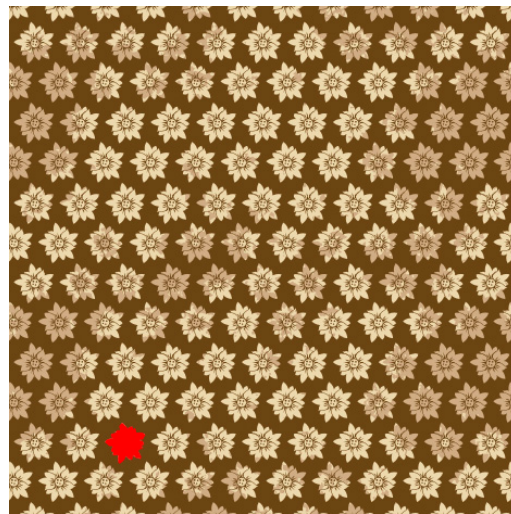


Figure 12. Introducing contrast in an image draws the eye because the difference interrupts the feeling of pattern.

In Figure 13, this is one of the first shots in the film *Brave* where the audience is introduced to the main character, Merida. There are several compositional principles at work to make her the focal point of the image, but certainly, one of them is color contrast. Merida's red hair has a large amount of color contrast with the rest of the more coolly lit scene drawing the viewer's eye right to the intended focal point, her face.



Figure 13. Still image from the Disney/Pixar film *Brave*. An example of color contrast between Merida's warm hair and the more coolly lit scene [17].

The most typical example of creating contrast through lighting is with value. Value is how light or dark an image is independent of its color. Placing strong areas of a bright value next to strong areas of a dark value will create a point of contrast in the image. Contrast in value (brightness/tonal) is easy for the eye to see, which is why black-and-white imagery is effective despite its lack of color. It also illustrates why lighting is a major tool in the establishment of emphasis and directing the eye of the viewer [3]. If we pull the color out of the scene with Merida and look only at the value, we can see that even without her vibrant hair color she is still the focal point of the image. One of the reasons is because of the value contrast happening in the scene. Placing strong areas of a dark value next to very bright values will create a point of contrast drawing the viewer's eye.



Figure 14. Value only representation of image.



Figure 15. An example of value contrast.

In Figure 14, Merida's dark dress is contrasting nicely with the brighter floor. Additionally, the light outside the hall through the door is brighter in value than her hair creating another point of value contrast in the scene. Figure 15 demonstrates this play of light over dark value and dark over light value. This is one of the ways lighters create emphasis and make a character pop out in a scene.

II.1.2.2. Tangents

Another way to create tension or emphasis in an image is through tangents, or two edges just touching each other. "The eye is not comfortable with tangent edges and wants to move them apart [10]." If tangent edges are creating a focal point where one is not desired and the objects cannot be moved, the lighting designer can try adjusting the lighting or shadow placement to reduce the visibility of the tangency. Shadows or hard-edged lights can create unwanted tangencies that will draw the eye. It is also possible to create tangencies from light and shadow as a tool to attract the viewer's eye towards an intended focal point. In Figure 16, the tangent circles create a visual tension that draws the viewer's eye [3].

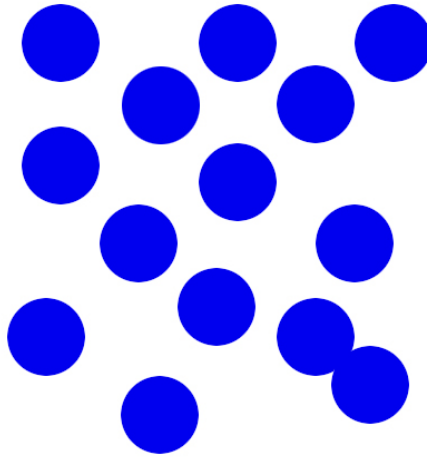


Figure 16. This figure shows how the tangent circles create visual tension to produce a focal point in the image [3].

Near tangency can create visual tension if two objects are close but not quite touching. This relates back to the concept of unity with continuous patterns. Our brains want to perceive a finished unit even if there are gaps in an object. One of the most well known examples of near tangency creating a focal point is in Michelangelo's famous painting *The Creation of Adam* in the Sistine Chapel, seen in Figure 17 [3].



Figure 17. *The Creation of Adam* crop, Michelangelo Buonarroti, c. 1511 [3].

II.1.2.3. Isolation

As a variation of the Gestalt grouping concept, an object that defies grouping will call attention to itself by its isolation [10]. It becomes a point of emphasis through tension, created by “the feeling of unpredictability caused by the lone element not belonging to the group” [10]. In Figure 18, the lone circle in the bottom left corner is the focal point of the image due to its isolation from the group [3]. If emphasis on ungrouped objects is not desired in the image, it is possible to link objects as groups using clever light and shadow placement.

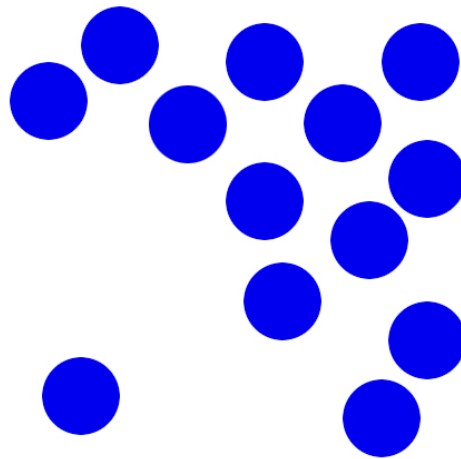


Figure 18. This image illustrates the Gestalt principle of creating a focal point with isolation [3].

II.1.2.4. Linear Elements

“The careful placement and emphasis of edges play an important role in leading a viewer’s eye through a composition, directing it to the intended subject [3].” Part of the challenge of maintaining the illusion of a three-dimensional image in a two-dimensional medium is ensuring the existence of vanishing points, lines that appear to converge toward one or more points in the image. “The eye travels along the edges and terminates at a vanishing point [3].” These vanishing points create a strong focal point in the image as seen in Figure 19, Michelangelo’s *The Libyan Sibyl*, painted on the ceiling of the Sistine Chapel. He uses the lines of the pages of the book, the curve of the woman’s arms, the designs on the woman’s garments, even the fingers of the cherub to her left

and the arms of the cherubs in the reliefs on either side of her to lead the viewer's eye directly to her face, the intended focal point in the image.

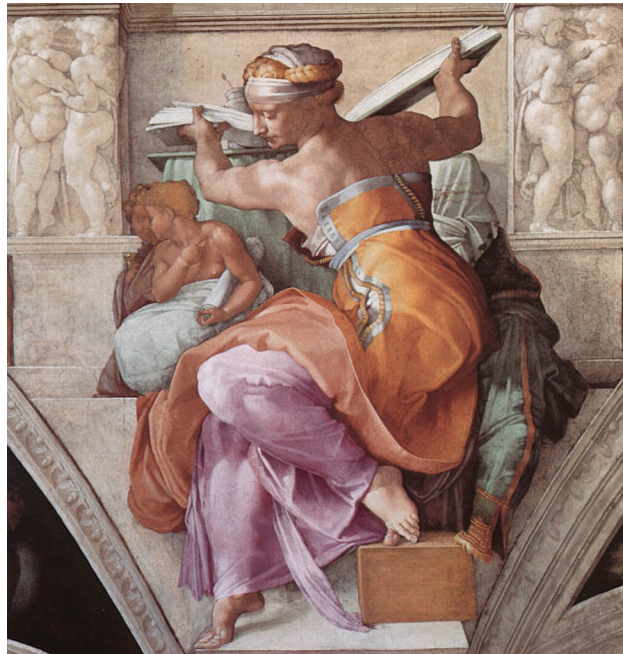


Figure 19. Libyan Sibyl, Michelangelo Buonarroti, c. 1508 [7].

If the vanishing point of the image is not the intended focal point, it may be necessary to create a stronger focal point at the desired area to minimize the pull of the vanishing point. It is also possible to create vanishing points with careful light and shadow placement to lead the viewer's eye to the intended subject. One of my favorite examples of using light and shadow to direct the viewer's eye is in Caravaggio's *The Calling of St. Matthew*, Figure 20 [11]. In this image Caravaggio has expertly placed the

light streaming in the window in a way that creates a clear linear element in the scene, leading the viewer's eye to the intended figure.



Figure 20. *The Calling of St. Matthew*, Michelangelo Merisi da Caravaggio, c. 1599 [38].

II.1.2.5. Shape

“The brain tends to characterize objects as either rectilinear or curvilinear. By creating an image with primarily one type, the other type becomes the point of interest [10].” For example, in an image with purely squares and one circle, the circle stands out

because it is a curvilinear shape in a group of rectilinear objects. Shapes that frame other shapes will also create focal points, for example, a character standing in a doorway [3].

“A long straight shadow in an image with a lot of curves may need to have less contrast or a softer edge than usual to keep it from drawing too much attention [10].”

Conversely, if emphasis is desired on an object that a shadow points to, it can be a useful tool for creating a focal point.

II.1.2.6. Size

Larger objects naturally tend to attract more attention than smaller objects in an image. Larger objects in a composition that are not the intended point of emphasis may need to be downplayed with careful light and shadow placement to keep them from drawing too much attention in a scene. In Figure 21, a still frame from the Pixar short film *For the Birds*, Director Ralph Eggleston comically plays with the idea of size and shape contrast.



Figure 21. Still image from Disney/Pixar short *For the Birds*. An example of emphasis through size and shape contrast.

II.1.2.7. Recognition

“Because of the human need for self-recognition, human or anthropomorphic characters will naturally attract more attention than inanimate objects [10].” When humans see another human, we immediately try to discern whether we know the person or not [3]. Even if we don’t recognize the person, we’ll continue to observe them to gain familiarity with them anyway [3]. “If two characters are standing side by side, one facing the camera and the other one facing away, we will spend more of our time looking at the character whose face we can see, even if the other character has the dialog. We don’t learn much from the back of someone’s head. We need the mouth and

especially the eyes to observe what the person might be thinking or feeling. The less we can observe, the less trusting we are of the person's intentions [3].”

II.1.2.8. Motion

In film, we have the added complexity of motion across a shot to either contribute to or detract from the focal point of the shot. If only one object is moving in a shot, the eye will be drawn to that object. Likewise, if all objects are moving except one, our eye will be drawn to the object that is not moving. Objects in a scene that create unwanted attention due to motion can be downplayed by the lighting to help minimize their pull away from the intended focal point.

When lighting artists are in doubt about the focal point of an image they close their eyes for a second then open them up looking toward the center of the image to see where their eyes are drawn. If their eyes are drawn to the intended focal point, well done! If not, lighting artists use the principles of unity and emphasis to understand why a different area is drawing their eyes. Once there is an understanding of why an object is creating an unwanted focal point, the lighter will then adjust the lighting to either downplay that area of the image, increase the emphasis for the intended focal point, or often, both downplay the unwanted focal point and increase the visual emphasis on the intended story point.

II.2. Creating Depth

Film, like traditional art, is a two-dimensional medium. “Any feeling of depth, space, or volume achieved is merely an illusion [3]”. Certain staging and lighting techniques can cause an image to appear flat. Other techniques will enhance the depth and thereby the visual interest of the image, drawing the viewer into the scene. The choice of how to handle depth in a computer-generated scene is an important aspect of the visual style.

In flat staging, the major planes in the scene are parallel to the camera. In dynamic staging, the major planes in the scene converge toward a vanishing point [3]. Famous cinematographer John Alton states that, “The more surfaces of an object that are visible, the better will be the picture [1]”. Imagine photographing a cube. If we set up the staging so that one of its sides is exactly parallel to the camera, as in Figure 22, then we can only see that one side of the cube [1]. However, if we adjust the camera to the side, as in Figure 23, suddenly we reveal two out of six of the sides of the cube [1]. This angle gives us more information about the object as well as creating a much more interesting composition. Followed to its logical conclusion, seeing the cube from overhead where three sides are visible could be considered even more visually interesting. There are many more staging decisions that add to the depth in an image but since they are concerned more with camera and object placement than with lighting, they are outside of the scope of this thesis.

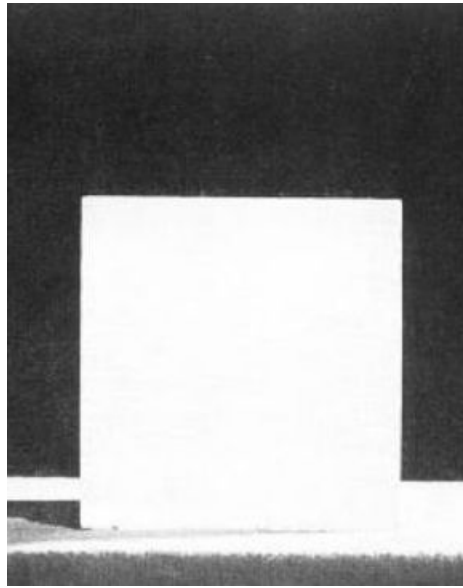


Figure 22. Flat staging of this cube is uninteresting as a composition [1].

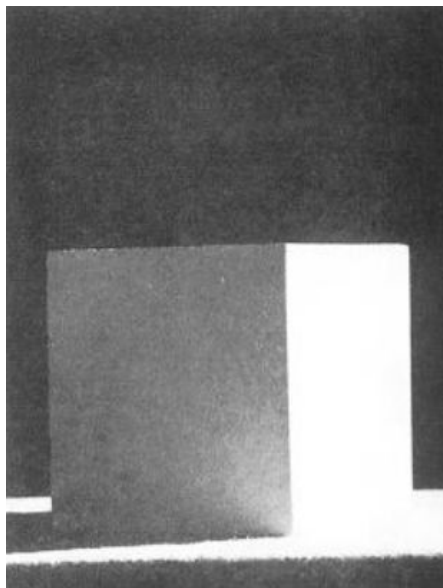


Figure 23. A more dynamic angle of the cube gives us more information and is more visually interesting [1].



Figure 24. Example of flat staging and lighting in the Disney/Pixar short film *La Luna*.



Figure 25. An example of staging and lighting that enhances depth in the Disney/Pixar film *Toy Story 3* [35].

Similar to staging, various lighting techniques can be employed to give an object or a scene a greater illusion of depth. The terms “painting with light” and “sculpting with light” can be applied to the use of light and shadow to reveal form and texture and to create the illusion of the third dimension in two-dimensional films and paintings.

Lighting techniques such as the choice of value and color, enhancing an object’s volume, separating planes of light, and adding atmosphere to scenes will enhance the depth of the composition [10]. Figure 24 shows an example of a scene lit with flat lighting. Figure 25 shows an example of a scene lit to enhance depth.

II.2.1. Value and Color

Depth in an image is enhanced if the foreground and background objects have value (brightness) and chromatic (color) separation [10]. Differences in value and color provide greater areas of contrast, thus drawing the viewer’s eye and creating an area of emphasis. Additionally, a progression of value can enhance the feeling of depth in an image.

When the foreground and background objects differ in value, a point of contrast is created in the image. This provides a focal point that attracts the eye. The emphasis created by the value contrast causes the object to “pop” off the screen and creates the illusion of depth in a two-dimensional image. A brighter value object will pop over a dark background more than if the foreground and background objects differ only slightly in value. The reverse is also true with a darker object over a brighter background. The

greater the amount of contrast between foreground and background, the greater the illusion of depth, as seen in Figure 26.

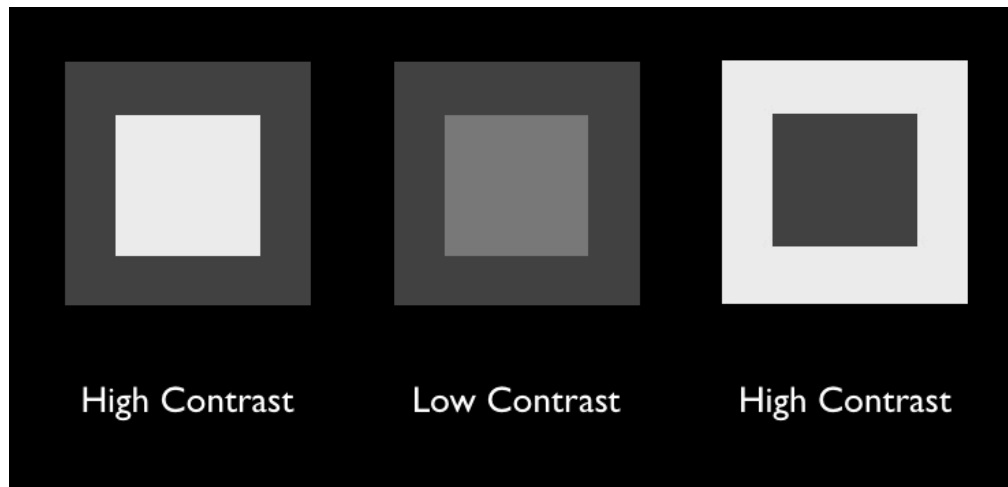


Figure 26. Example of enhanced value contrast causing visual tension, the greater the contrast, the greater the illusion of depth.

Similarly, color contrast with foreground and background elements will increase the feeling of depth in an image. Colors that are opposite each other on the color wheel will cause a greater illusion of depth than colors that are similar in hue. A warm subject over a cool background will impart more apparent depth than a subject and background with the same color temperature [3]. Additionally, warm colors tend to feel more near than cooler colors. There are multiple theories as to why this is, one of which is that we are used to seeing the cooler colors of the sky and trees as the “background” and the warmer hues of buildings and people as “foreground”. In Figure 27, most will find it easier to see the image on the left as an orange frame with a hole in the middle [4]. Most will find it easier to see the image on the right as a small orange box in front of a larger

blue square [4]. With hue and color temperature contrast it's important to remember the contrast creates visual tension and thus the illusion of depth.

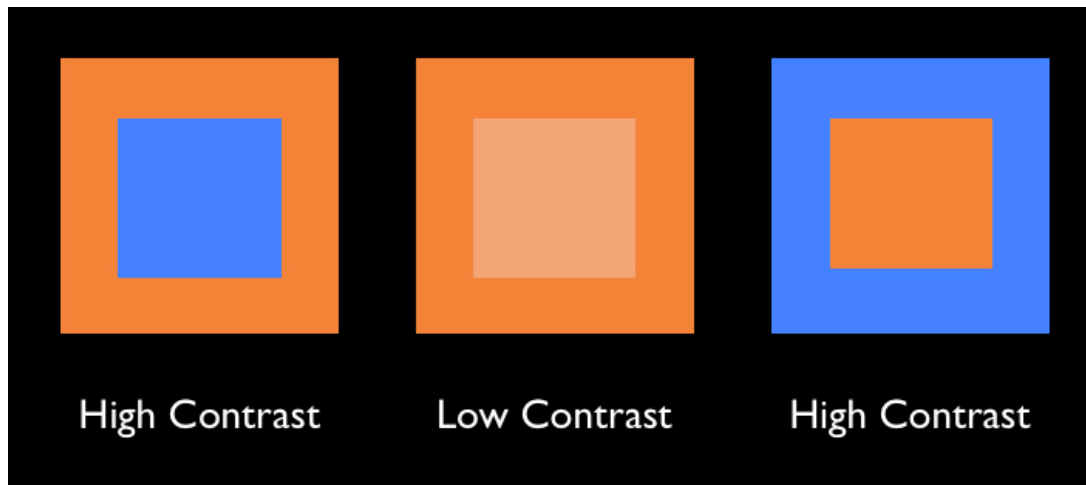


Figure 27. Example of enhanced color contrast causing visual tension, the greater the contrast, the greater the illusion of depth. The image on the left appears to be an orange frame with a blue hole in the middle. The image on the right appears to be an orange box on top of a larger blue square. The image in the center imparts less depth due to the lack of color contrast. [4].

A movie theater by nature exhibits a feeling of depth, since we are sitting in a dark room looking at a bright screen. “In order to continue this depth on the screen, the progression from dark to light must be followed up [1].” Typically, more distant objects tend to appear darker and closer objects tend to appear lighter. This value progression can be reversed however so the brighter objects are the most distant. This technique will “draw the viewer into the frame” as seen in Figure 28.



Figure 28. Cropped still image from the Disney/Pixar film *Up* [24].

II.2.2. Volume and Space

Just as value contrasts create the illusion of depth between foreground and background objects, value shifts across the surface of an object will enhance the form and create the illusion of depth in a two-dimensional image.



Figure 29. *Madonna in Majesty* crop, Cimabue, c. 1285 [12],
Benois Madonna, Leonardo da Vinci, c. 1478 [13].

In Figure 29, compare the image of the Madonna and Child as depicted by Cimabue in 1285 with that done by Leonardo in 1478. In Leonardo's version he paints a much greater range of values across the surface of objects giving a greater illusion of depth in the image. About this technique, da Vinci said:

"I would remind you O Painter! To dress your figures in the lightest colors you can, since, if you put them in dark colors, they will be in too slight relief and inconspicuous from a distance. And this is because the shadows of all objects are dark. And if you make a dress dark there is little variety between the lights and shadows, while in light colors there will be greater variety [16]."

The use of light and dark to define three-dimensional shape in paintings is known as *chiaroscuro* from the Italian "chiaro" meaning light and "oscuro" meaning dark. In contrast, Cimabue's Madonna uses a limited range of values causing the forms to appear much more flat.

In lighting computer graphics scenes, we can apply the concept of enhanced local value contrast to create enhanced volume in our subjects by adjusting the light position and quality to carve out an object's form. When we model with light we illuminate our subject so that the two-dimensional object shows its three-dimensional form [4].

Adjustments in light position will greatly change the dimensionality of an object. For example, in Figure 30, one of the oranges is lit to enhance its three-dimensional form; the other is flatly lit, suppressing the orange's form. The orange on the left is lit with a soft frontal lighting that reduces the amount of value across its surface and as such, reduces its three-dimensional form and texture [3]. The orange on the right is lit from a three-quarter position with a harder light that has sharper shadows [3]. The three-quarter light position enhances the falloff of the light across the surface of the orange giving it a greater value contrast across the surface. The greater value contrast enhances the texture and three-dimensional form of the orange.

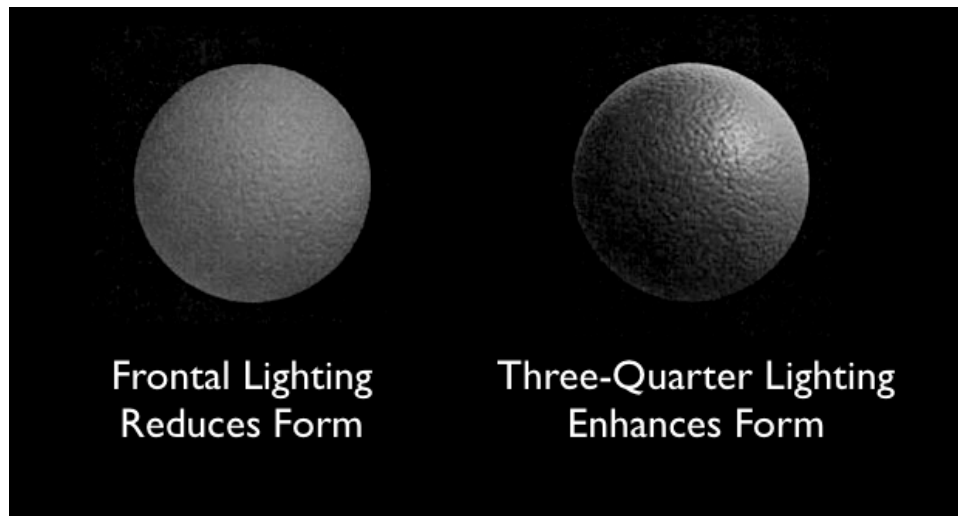


Figure 30. The orange on the left is flatly lit; the lighting suppresses the form and texture. The orange on the right is lit to enhance the three-dimensional form and texture of the object [3].

II.2.3 Planes of Light

Just as value contrast in foreground and background objects gives an image more depth, a complicated image can be arranged into simple planes of light to visually simplify a scene and create a greater sense of depth. A lighting plane is defined as “a collection of objects or subjects that are parallel to the camera plane and are lit as a unit to contrast with other planes” [10]. These planes are defined as utilizing light for the purpose of creating a heightened sense of depth through layers [10]. When planes of light are carefully illuminated so that lights and darks overlap each other, a heightened sense of form, depth, and appeal is achieved in the image [3].

II.2.4. Atmosphere

Another way we can create depth in an image with lighting is to take into account the effect of atmosphere on the surface lighting of objects and to add atmospheric effects over distance. The visual effect of atmosphere we notice when looking into the distance at a series of mountains is caused by water and dust particles that hang in the air and scatter and reflect incident light. The result is that as the objects recede with distance their saturation and contrast is reduced. Objects can also be tinted by fog with distance depending on the angle of the camera and the light source and composition of the particles [3]. “Atmosphere that is backlit will appear to brighten objects over distance, while front lit atmosphere will appear to darken objects over distance [3].”

Typically atmospheric effects are used to create an increased sense of depth in an image, however, heavy atmosphere can also be used to limit depth and heighten a viewer’s emotional reaction [3]. Imagine walking along a dark path at night when thick fog rolls in. The lack of depth created by atmosphere increases the feeling of uneasiness because information about the location is obscured. This can lead to a feeling of unpredictability and apprehension about the situation.

II.3. Enhancing Mood, Atmosphere and Drama



Figure 31. A still image from *The Big Combo*, shot by John Alton, ASC. Demonstrates how a lack of lighting enhances the mood of a scene [2].

“Where there is no light, one cannot see; and when one cannot see, his imagination starts to run wild. He begins to suspect that something is about to happen. In the dark there is mystery [1].” John Alton hints at one of many ways lighting artists can use clever lighting design to affect the viewer’s emotions and enhance a story point. In fact, an infinite number of combinations of lighting properties and setups can be created for a wide range of visual and emotional effects [10]. Using a lack of light to enhance mystery, for example the scene in Figure 31, and using an abundance of light to create a cheerful mood are two of the most common examples of how lighting choices

affect mood. In addition to the number of lights - the lighting style, quality, motivation, and the types of lights work in unison to establish a sense of mood and drama.

II.3.1 Style

When approaching a lighting design, one of the first choices that must be made is to determine the appropriate style of lighting to be used for the scene. “Lighting styles are described by their tonal range, which is the range of values from the darkest dark to the brightest highlight and the gray values in between [10].” The character and mood of an image is greatly affected by the range of tonal values from light to dark and by their distribution within the frame.

II.3.1.1. Key Position

Comedies and other light-hearted stories are typically lit with a high-key lighting style. A high-key scene is well lit with a lot of soft fill light and typically doesn't contain hard shadows. The dark areas are few and the overall contrast of the scene is low. The ratio of fill light to key light is low. This means that the total intensities of all the fill lights in the scene are close to or greater than the intensity of the key light [10]. A scene with very low contrast, composed of a range of shades of middle tonality will convey bleakness or calmness. There is little suspense in the image since the audience

can clearly see everything and little to nothing is left to the audience's imagination as seen in Figure 32.



Figure 32. An example of a high-key scene from the Disney/Pixar film *Up* [24].

In contrast, a low-key scene is darkly lit with the emphasis on a few areas that are brightly lit. These scenes have little to no fill light and lots of areas of shadow. Details are only hinted at, leaving the viewer to fill in the visual gaps. They are high in contrast because they have a high key-to-fill ratio [10]. The key light intensity is much larger than all of the fill light intensities combined. These scenes tend to be more visually interesting since they challenge the viewer. A very high contrast scene will have a graphic quality and convey a sense of energy and unrest. They are also more mysterious since the audience cannot clearly see everything in the scene as seen in Figure 33.

“Light is used to direct the viewer’s attention, the darkness to stimulate the viewer’s imagination [10].”



Figure 33. An example of a low-key scene from the Disney/Pixar film *Up* [24].

II.3.2. Quality of Light

In addition to the tonal range of an image, the quality of the light source has a profound effect on the mood created in the scene. When we talk about light quality, we’re describing characteristics of the light, hardness or softness and color [10]. These characteristics will be motivated by the time of day and the location of the scene, but can vary to accentuate the mood of the scene.

II.3.2.1. Hard vs. Soft

Whether a light is considered hard or soft depends on the shadows and highlights it creates. Hard lighting is direct light, meaning it comes directly from the source. Examples of sources are the sun, a lamp, a flashlight, or a fireplace. Hard light is sharply focused and appears to come from a very small or very distant source [4]. Hard light casts very crisp shadows and tends to create small highlights. The harshness of the shadows makes the image feel colder and less visually pleasant than soft light. Soft light has been diffused or scattered in some way [4]. It has soft-edged shadows instead of crisp shadows and less focused highlights. It's typically characterized by a large light source located closer to the subject. The larger the source of the light, the more the light will wrap around an object. Soft lighting tends to be romantic and inviting and gives the viewer a feeling of safety. "Daylight scenes are usually softly lit except for direct sunlight. Night scenes, especially exteriors, tend to be lit with harder lights [10]."

II.3.2.2. Color – Physical Behavior of Light

Color can be used deliberately in lighting to elicit a strong emotional response from the viewer to enhance the mood of the scene, for example the color green in Figure 34. Color is a complex phenomenon. It is determined by the wavelengths emitted by a light source and reflected off surfaces. It is affected by human perception [27]. To

understand how colors affect our emotions we must first understand how color reacts in the context of lighting.



Figure 34. Example from *Toy Story 3* of using color to elicit a strong emotional response from the viewer [35].

Light exists within the visible part of the electromagnetic spectrum, from wavelengths of 400nm to 700nm. This is the area from just above infrared to just below ultraviolet, as seen in Figure 35 [19]. The entire range of the electromagnetic spectrum extends from cosmic and gamma rays to radio waves. The visual cortex distinguishes individual wavelengths as distinct colors [20]. All of the colors of the spectrum are visible in white light as witnessed by the phenomenon of a rainbow [27].

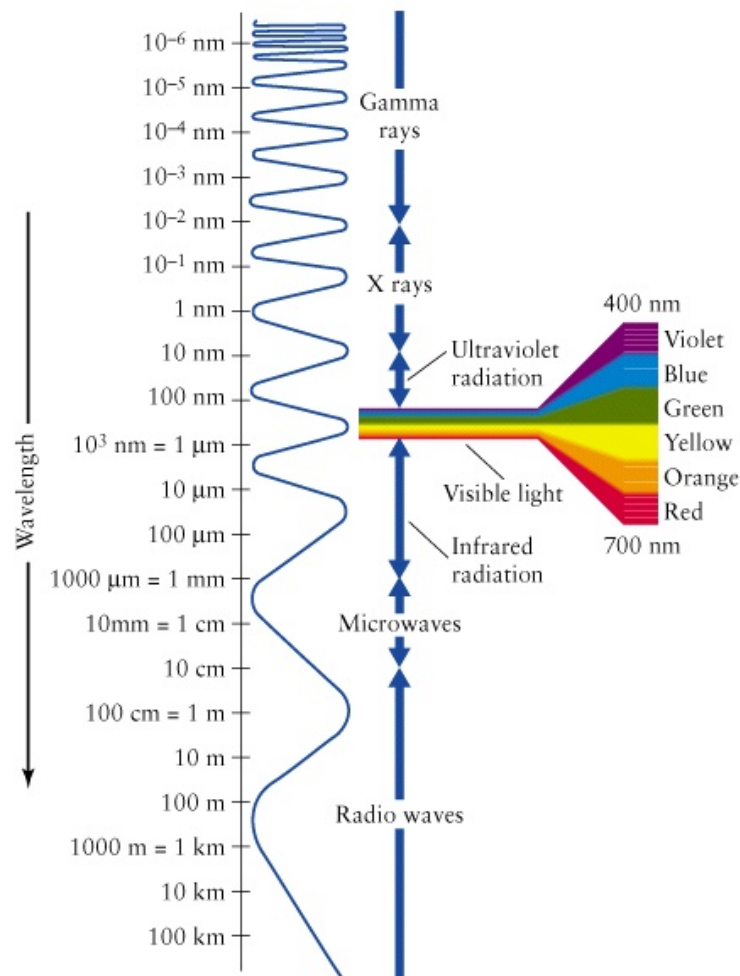


Figure 35. The electromagnetic spectrum, light exists in the visible part of the spectrum from 400nm to 700nm [19].

“Color is the visual effect that is caused by the spectral composition of the light emitted, transmitted, or reflected by objects [27].” Stated more simply, “The color of a surface is determined by how it reflects the light that illuminates it [3]”. Light shines from a source such as the sun, to an object, for example an apple. Light waves are reflected off of the apple and reach our eyes. The surface of a red apple absorbs all of

the colored light rays, except for red, and reflects this color to the human eye [27].

When the eye receives the red wavelengths it sends a message to the brain. The brain then perceives the color as red.

The type of color vision a species has depends on its color-detecting equipment. Some species see no colors and some species see colors not visible to the human eye. As humans, we are “trichromats” meaning we have three kinds of color receptor cells, red, green and blue, called cones, in our eyes [27]. They are also referred to as long (L), medium (M), and short (S) for the types of wavelengths they are sensitive to (red, green, and blue respectively) [5]. Animals like bees are also trichromats, but one of their cones is sensitive to colors in the ultraviolet range of the spectrum. This gives them the ability to see colors that humans cannot see [27]. A color or hue is the result of the output of stimulation from the three types of cones. If all three of our cone cells are stimulated equally then white is seen. If none are stimulated, black is seen. Most of the time the three types of cells are stimulated differently - resulting in different colors being seen.

In addition to cones, the eye has photoreceptors called rods that are ultra sensitive to light and allow humans to see in very low light levels, such as moonlight. Rod cells do not distinguish between colors and are not good at seeing detail. Objects seem to have less color and definition in the dark. Rods are insensitive to color, but are more than a thousand times more sensitive to light than cones are. Their sensitivity is also shifted towards the shorter wavelengths roughly between where blue and green reside. This is why we have a harder time distinguishing reds and yellows at night when

rods are the predominant photoreceptors. Rods are responsible for our peripheral vision and our night vision.

The numbers and placement of cones and rods in our eyes helps determine how responsive our vision is to certain hues. Our cones are composed of roughly 63% red cones, 31% green cones, and 6% blue cones [5]. The low amount of blue cones in our eyes results in our poor ability to discern blue colors. The large amount of red and green overlap in wavelength sensitivity, results in our eyes being most responsive to yellow, green, and orange light

Now that we understand how the eye sees light as different colors, we can understand how the color we perceive an object to be is directly related to the lighting situation. “Unfamiliar objects appear just as the eye perceives them; that is, the apparent color and value are determined by the actual wavelength of the reflected light. For familiar objects, the principle of color and brightness constancy takes effect [3].” This principle states that if the color of an object that the viewer is familiar with differs from what the viewer expects, the difference is attributed to the affect of the environment on the object. For example, if a viewer sees a blue person, most likely the person is not actually blue, rather the viewer understands that they are seeing a person under a blue lighting setup. The brain takes that knowledge and evaluates the rest of the scene, shifting the overall color of the scene toward what it thinks it should look like under white light [3].

II.3.2.3. Color – Emotional Response

Changes in lighting color can have a huge impact on the overall mood of the scene. According to Sharon Calahan, “Naturalistic lighting mimics the complementary palette found in nature [3]”. Daytime scenes typically have a warm key for sunlight with cool fill to simulate the blue sky. Night scenes often have a blue key light for the moon, with practical lighting sources such as interior incandescent lighting and candles or firelight providing a soft warm fill.

Colors can also elicit emotional responses from a viewer. These responses can be reactions to associations with our past or our cultural heritage [3]. Different people can have different responses to the same color. The same person can also have different responses to the same color depending on the context of the color. It’s possible to draw some generalizations about how colors elicit emotional responses. In general, saturated colors tend to advance and excite, less saturated colors tend to recede and feel oppressive as seen in Figure 36 [3]. Scenes lit with analogous colors feel more somber than scenes using complementary colors [3].

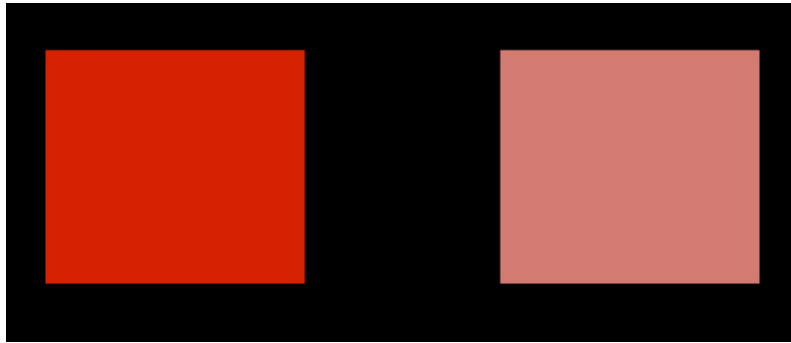


Figure 36. An example of saturated color being more exciting, less saturated color being more somber.

Warm colors, colors in the red-yellow spectrum tend to be exciting and energetic, as seen in Figure 37. Red is associated with love, passion, danger, blood, anger, embarrassment. Red lights can cause an increase in breathing, heart rate, and central nervous system functioning [28]. Orange typically indicates fun and cheer. Yellow feels sunny and typically recalls cheerful memories of summer or warmth [3].



Figure 37. Warm colors: red, orange, and yellow.

Cooler colors, such as blues, purples, and greens tend to represent calm and peacefulness, for example the swatches in Figure 38. Blue is associated with deep thought, spirituality, and melancholy, hence the term to have the blues [28]. Blue can

also elicit feelings of calm [28]. Blue colors tend to decrease nervous system response. Purples typically signify royalty, culture, and sophistication. Green is typically associated with nature, growth, wealth, and good luck [28]. It can also have a negative connotation when associated with money or envy. Green lighting is not a flattering color for human skin. It can look “eerie, chemical, artificial, and unhealthy” [3]. Human skin is much more appealing in warm light.



Figure 38. Cool colors: green, blue, and purple.

Shades of white, black, and gray also have effects on the emotional response of the viewer. White typically feels “pure, virginal, innocent, classical, and youthful; but it can also feel sterile and emotionless” [3]. Black is associated with elegance and formality, it can also evoke night, death, and mystery. Gray is the color of oppression, sadness, and isolation. Gray can feel institutional, indifferent, sad, and cold [3].

II.3.3. Motivation of Light

The mood of scene can be greatly enhanced by the motivation of a light source in a scene. In some scenes, props or architecture will indicate the sources of light in the scene. Other times, light can be placed for purely artistic reasons to produce a pleasing visual result. Typically, there are compromises made between implying practical sources and creating more artistic pictorial lighting. If there is a practical source of light in a scene that the viewer can see (or is implied), such as a lamp or window, that light is said to be a logical source [10]. If there is a logical source in the scene, the viewer will expect the overall light direction to emanate from the source they see. Practical sources such as campfires, flashlights, and lamps can provide excellent opportunities to enhance mood and drama in a scene by creating the feeling of a safe space created by the light in a dark scene. Additionally, pictorial lighting choices can be made to enhance beauty or emotion in a scene.

II.3.4. Number of Lights

The number light sources in the scene will help determine the mood of the scene. A candlelit scene can feel warm and romantic. A bank of fluorescent lights can feel sterile and cold [10]. Often several lights are used to simulate one logical source, but the number of logical sources is kept low so that the light direction is clearly established.

II.3.5. Light Functions, Purpose, Placement, Direction, and Intensity

Once the lighting designer has determined the overall mood of the scene, how the tonal range of the image will contribute to the mood, where the light is motivated from and how hard or soft the light will be, the next thing to consider is the specific type, purpose, placement, direction and intensity of each light [10]. There are typically five main light functions used in traditional cinematography, key light, fill light, backlight, kicker and bounce light. A light's function describes how it is used on a subject to shape the subject's form.

II.3.5.1. Key Light

The key light is the brightest light striking the surface of a subject. It is the subject's main illumination, defines the dominant angle of light and thus defines the main light direction in the scene [23]. It is also usually the light that casts the darkest and most visible shadows in the scene [4]. As the dominant light source, the key light more than any other affects the overall mood of the scene.

Key light placement, quality, color and intensity all work together to enhance the mood of the scene. The placement of this light has the largest affect on the mood and dramatic quality of the image by controlling the direction of the light as it strikes the subject [10]. One of the biggest, most important decisions you make when lighting a subject is direction of the key light [4]. Successful modeling of a subject with the key

light will show light falloff across the sides of the object with no two sides being equally illuminated. If the key light position is too close to the camera angle, the form will flatten out and the key light will not properly shape the subject as we saw in Figure 30 with the flatly lit orange. The key light is conventionally placed 30-45 degrees to the side and above the subject relative to the camera axes [10]. This depends however, on the motivation of the light source in the scene as well as the intended mood. We'll discuss how key light placement and quality reveal a character's personality in section II.4.

II.3.5.2. Fill Light

The fill light is a soft, low-intensity light source used to fill in shadow areas [10]. It can be used to simulate illumination from dimmer light sources in the scene, or to simulate indirect illumination in the scene. Indirect illumination is the light that is reflected from the key light off of other surfaces in a scene and bounces around adding an additional overall low-level illumination to the scene. Since fill light is simulating either low level lights in the scene or light that has bounced around, scattered, and lost energy, it is typically soft, without noticeable shadows or sharp highlights. Fill light can be placed anywhere in a scene, but it is often placed closer to the direction of the camera than the key light so that it fills in the shadowed areas created by the key light [10].

The amount of fill light in a scene greatly impacts the overall mood of the scene as it controls the overall contrast ratio, as discussed in section II.3.1. When the key-to-

fill ratio is low there is little suspense in the image since the audience can clearly see everything and little to nothing is left to the audience's imagination. Conversely, when the fill light intensity is very low in a scene, creating a high key-to-fill ratio, these scenes tend to be more visually interesting and more mysterious since they challenge the viewer.

II.3.5.3. Back Light

Backlights were traditionally used in black and white films to separate a character from the background. This was especially common with dark-haired actors against dark backgrounds [4]. Backlight is not necessary in every scene. Often there is already enough separation between the foreground and background objects. It can however, be a useful tool for creating a romantic mood or special emphasis on a particular character. Backlights in traditional cinematography are positioned behind the subject so that it is pointing directly at the camera. The result is a thin rim of light around the edge of the subject [10]. Soft backlight tends to look more natural and visually pleasing than hard backlight with sharp shadows. Occasionally, multiple backlights are necessary to create a wrapped light effect around a character.

II.3.5.4. Kicker

A kicker light is used for surface modeling and character enhancement [10]. It is used to define the edge of the subject that is opposite the key light. It's typically positioned three-quarters back and placed lower than the backlight. Depending on the intended mood, it can be soft and add a gentle glow or be hard and intense to add a strong glare to the side of the face. It may serve as a temporary second key whenever the subject turns toward it [26].

II.3.5.5. Bounce Light

To simulate the effect of light bouncing off of nearby surfaces, bounce lighting is often used. For example, if a character is standing next to a bright warm wall, a soft, low-level, warm colored bounce light may be used to simulate the light that would bounce off of that wall and onto the character. In computer graphics images, we generally refer to bounce lights as the lights that simulate light bouncing off of the ground and filling in under the character's chin, eyebrows, and nose. Similar to fill lights, since bounce lighting simulates indirect illumination, the light is very low level and soft with little discernable shadows.

II.4. Revealing Character Personality and Situation

Calahan states, “The quality, color, and direction of light can give the audience impressions about the personality or character of the subject. They can also say something about the dramatic situation or emotional state of mind, in which the subject currently finds himself [3].” If a lighting artist’s role is to assist in conveying a specific story point, revealing a character’s personality is often key to achieving that goal.

II.4.1. Quality

In section II.3.2 we discussed how light quality can affect the mood of a scene. The color, position, and hardness or softness of a character’s lighting similarly evokes emotions about a character’s personality. Just as soft lighting can be used in a scene to give it more of a romantic, inviting feel, soft lighting is used to make a character more appealing and desirable, as seen in Figure 39. It can round out the delicate apple of cheeks on a woman, or be used to fill in wrinkles on an older face. It’s typically associated with the glamour lighting and diffusion used in 20s and 30s Hollywood movie close-ups to make the actresses appear soft, sensual, and appealing. By contrast, harsh lighting can make an appealing face unappealing by accentuating wrinkles and harsh lines. Harsh lighting can reinforce the power or stature of a masculine character by accentuating strong jaw lines and angular features.

II.4.2. Color

The same emotional responses the viewer has to color in a scene, discussed in Section II.3.2.3, will occur when adding color to a character's lighting. Clever lighting artists can introduce subconscious responses in the viewer utilizing a carefully placed practical light source. An example would be introducing a neon green light source for a character whose personality is envious or greedy, white light to indicate a character is pure of spirit, or red to reinforce a passionate temptress or an evil villain.

II.4.3. Direction

A character's key light placement and direction can be one of the most useful tools for varying a character's personality. Hard under lighting is classically used to signify an evil villain, for example the character in Figure 40. We most likely associate this angle with odd or evil behavior because it is such an unusual angle to see a face lit from and because the harsh lighting throws crisp shadows across the eyes adding a mysterious and uneasy quality. The viewer will feel uneasiness and tension if lights are placed so that a character's facial expression is obscured. In contrast, soft under lighting appears sensual [3]. Characters that are lit from directly overhead can look dreary if they are looking down, but spiritual and hopeful if they are looking up towards the light. [3].



Figure 39. An example of using soft lighting to create a romantic mood from the Disney/Pixar film *Up* [24].



Figure 40. An example of using harsh under lighting to signify an evil character from the Disney/Pixar film *Ratatouille* [9].

II.5. Conveying Time of Day and Season

Another critical fundamental of lighting design is to correctly convey the intended time of day and season for the scene. Time of day is an important indicator of mood and atmosphere. Placing the key light directly where the sun's position in the sky would be for a particular hour of the day is generally not necessary or aesthetically pleasing. What's more important is to pay attention to the overall key-to-fill ratio, shadow length and density, and the color of light sources in the scene.

II.5.1. Dawn

“At dawn, the light is blue, warming as the minutes pass [10].” There is often a lot of fog or atmosphere in a dawn or early morning scene. The fog is typically produced during evening hours when the air at ground level is cooled enough to cause saturation so the air can no longer hold water vapor. The vapor precipitates out into small droplets of condensation. Shortly after sunrise the fog disappears because surfaces heat up with the sun [29].

II.5.2. Morning

Morning light is typically cheerful and optimistic. It brings the promise of a new day [10]. The sun is lower in the sky and casts long shadows. There is typically a high

key-to-fill ratio because the sun hasn't risen very far in the sky so it isn't scattering as much as it will later in the day. Shadows are typically dense and the light in general is very directional and slightly bluish.

II.5.3. Noon

Noon lighting is typically not the most aesthetically pleasing, but the harshness of it can be useful for a specifically intentional mood. The sun is high overhead so shadows are straight down. This tends to flatten images and make color appear less saturated [10]. There is a lot of fill light bouncing around, so the overall contrast of the image is quite low. The light color tends to be very low saturation, tending more towards white. Figure 41 is an example of harsh noon lighting from the film *Rango*.



Figure 41. An example of harsh noon lighting from the film *Rango* [14].

II.5.4. Sunset

As the sun lowers in the sky, the shadows become much longer and the light color tends more red. The overall image contrast increases as the fill light in the atmosphere decreases. Light becomes more directional and shadows denser. Evening light can be dramatic and romantic, but it can also be melancholy. “The day is coming to an end, slowing down [10].” Figure 42 is an example of romantic sunset lighting from the film *Wall-e*.



Figure 42. An example of romantic sunset lighting from the Disney/Pixar film *Wall-e* [18].

II.5.5. Night

For night scenes, it's typical to use hard, directional lighting when indicating moonlight. Practical sources like fireplaces and lamps tend to be softer. The practical sources visible in the frame should determine the quality of light [10]. The contrast in a night scene tends to increase dramatically due to the low level of fill light. The angle of light in a night scene tends to be more of a three-quarters-back key with very little fill from the front [10]. Specular highlights tend to become more noticeable at night because of the lack of fill and directionality of the key. Since so much of a night scene is often left in shadow, night scenes have a mood that is mysterious and foreboding. However, the presence of a practical source in the scene can also create a cozy and safe space near the pool of light that fades into the unknown dark beyond.

The color selection for moonlight can be tricky because the light that we see from the moon is actually warm light from the sun reflected off of the moon. The light itself is not cool. As discussed in section II.3.2.2, we perceive it as being cool because the rods in our retina which are light sensitive do not distinguish colors and are much more sensitive to blue and green wavelengths. As light dims the rods take over from our more color sensitive cones. In very dim light we're virtually color blind. Additionally, moonlight tends to falloff much faster than sunlight since the source is much more dim. Figure 43 is an example of night lighting from the film *Toy Story 3*.



Figure 43. An example of night lighting from *Toy Story 3* [35].

II.5.6. Seasons

Similar to the cycles that light go through in a day, as the seasons change, light goes through yearly cycles and thus moods. “Spring is a new beginning and the light is clear and cool, autumn light is warmer and nature is winding down for the year [10].” Winter light is typically cooler and the angles remain more horizontal since the sun doesn’t climb as high in the sky [10].

II.6. Related Work - Cindy Hong M.S. thesis

Cindy Hong's M.S. thesis in 2002 entitled *Lighting Studies: Interpreting Lighting Styles from Traditional Media in Computer-Generated Imagery* consisted of analyzing the lighting in four paintings and one movie film frame to determine the lighting style for each of the images [22]. She analyzed the images in terms of the direction of the key lighting source, the time of day indicated by the lighting, as well as the color of the key and fill sources. Hong then applied those lighting cues adapted from 2D artwork and lit a 3D computer generated scene using the same lighting quality. The result was digitally lit 3D images that closely matched the original 2D artworks she selected. Figure 44 shows one of the results of her research.

In Hong's thesis she is beginning with a traditional 2D artwork, deriving the lighting style from the artist and applying that style back to a 3D computer generated scene. This differs from my approach in that I am taking 3D lighting fundamentals and applying the production lighting critique process to a traditional 2D artwork to adapt the lighting of that 2D artwork directly. These theses are similar in that they are both concerned with what we can learn by blurring the lines between lighting in the traditional 2D world of art and lighting in the 3D computer-generated world.



Figure. 44. Hong's digitally relit version of *Wyeth's Boy with Pole* [22].

CHAPTER III

METHODOLOGY

For this thesis, I selected one well-known 2D artwork to relight for each of the five fundamentals of lighting. I applied the 3D shot lighting critique process to each selected 2D artwork. I acted as Director and DP to create a narrative - inspiring lighting notes for each image. I critiqued each image on its ability to convey the intended lighting principle. I then digitally relit the image based on the notes of the critique. The results are 2D images that are easily recognizable as adaptations from the original paintings, but that communicate the intended lighting principle thereby communicating a distinctly different visual impression.

III.1. The 3D Production Shot Lighting Critique Process

To understand how I applied the fundamentals of lighting in a 3D shot lighting context, it is important to understand the relationship between a lighter and his or her DP and what the 3D shot lighting critique process is like. As there aren't many sources that describe this process, for this section, I'll rely on my industry experience over the past six years working with Sharon Calahan and other notable DPs.

As mentioned in the Introduction section, the production lighting process can roughly be broken down into the following steps.

- Notes – The director of Photography analyzes the shot and gives notes.

- Application – The lighter uses given tools to achieve the notes.
- Results – The lighter shows the resulting images to the DP.
- The above process repeats until the shot is ready to show the Director or until the DP approves it.

III.1.1. Notes

A shot lighter's job begins when she is assigned a shot (or several shots). When a lighter is assigned a shot she will request a walkthrough with her DP. A walkthrough is time with the DP where lighters receive creative direction, in the form of verbal notes, on their shots. During walkthroughs the lighter will present her work to the DP and in just a few short minutes the DP must convey the intended direction for the shot. During that time, the DP will look at the image and analyze it in terms of the story point of the shot and how it's fitting in context with the set of shots around it. Just a few of the many things the DP is watching for are to make sure that the viewer's eye is directed to the intended story point; that the image has the correct amount of depth overall and across the surfaces of the objects; that the color and mood of the shot convey the intended story point; that the characters look as expected and have the correct lighting to reinforce their personality in the shot; and that the image conveys the intended time of day that the shot is set in. In addition to concerns about continuity with surrounding shots, the DP is analyzing the image to make sure that the fundamentals of good lighting design are working in the image. The DP will then give the lighter notes for how to adjust the

image in order to accomplish the intended visual goals of the shot. I have notepads absolutely full of lighting notes from past films. Just a few quick examples are:

- Adjust the position of the key light so that the nose shadow falls more appealingly across the character's face.
- Allow the light to falloff across the surface of the wall so it doesn't feel so flat.
- Brighten the intensity of the key light on the main character so she pops out more in the frame.
- Increase the density of the atmosphere to conceal more of the background in the shot.

III.1.2. Application

Once the lighter receives her notes during walkthroughs, she goes back to her desk and develops a plan of attack for how to approach the lighting adjustments based on the notes received. This plan often involves careful analysis of the image itself in context with the notes. It may also involve analyzing reference material in the form of a pastel from the DP or art director, other images from the film, or even images found online which convey the intended note.

DP notes are typically very specific in terms of the expected results in the final image, but they often leave the method of how the note is achieved up to the lighter to decide. For example, the DP may suggest that an object in the foreground is made darker so it attracts less attention from another part of the shot. It is up to the individual

lighter to decide if the lights on that object need to be turned down in value, if the lighting position needs to shift off of those objects, or if a carefully placed shadow might do the trick.

During the application phase, it's extremely important that the lighter continues to analyze the image in terms of the fundamentals of lighting design as he or she is applying the notes. Often addressing one note makes an entirely new problem appear. A good shot lighter assists her DP by having a solid understanding of the five fundamentals of good lighting design so as she is lighting the image, adjustments are continually being made so the overall lighting goals are maintained.

III.1.3. Results

Once the lighter has a first pass completed for the notes the DP has given, she signs up for walkthrough time again and brings the shot back to the DP. The most typical result of a first pass of notes is that the lighter either did not push the note far enough, for example, did not darken the foreground object enough; went too far on a note, by darkening the object too much; introduced new notes, for example, now a different object pulls the eye; or the notes look good and the DP makes more refined notes since the shot is progressing. An example of more refined notes are to add bloom to a window, add extra specular hits to a metal object, or adjust the eye highlights of a character.

The walkthrough process continues until the DP feels the shot is either ready to approve or ready to show to the Director of the film for approval. On some shows the DP finals lighting shots themselves, on other shows the Director of the film finals the shots. It depends on how the particular show is organized. The walkthrough process may happen two to four times for an average shot, or many, many, many...many times for a very difficult shot.

III.2. Selecting the 2D Works of Art

III.2.1. Criteria for Selection

Through some trial and error, I determined the following selection criteria for the 2D images that would be relit according to Sharon's fundamentals:

- Each of the selected works of art must be well known enough to be considered famous.
- The images must be able to be adapted digitally to the specific principle.
- A few different styles of painting should be represented by the final collection.
- I must have a personal appreciation or connection to the images

III.2.1.1. Must be Famous

When selecting the 2D works of art, one of the criteria I determined was that each work of art must be well known enough to be considered famous. By famous or well known in this context, I am not suggesting that a reader with absolutely no art background or interest in art will necessarily have familiarity with the painting, but rather, that anyone in a creative, visual field, with a reasonable background and interest in art will be familiar with the image. To create a unique viewpoint on a work of art, it is important that the reader already have a familiarity with the images. Selecting works that are well known is not only critical to the intent of changing the reader's viewpoint, it will also increase the reader's emotional impact when the images are relit according to the fundamentals of lighting design.

III.2.1.2. Must be Able to be Adapted to the Specific Principle

Selecting images that have the ability to be adapted to the specific principle is a criterion that has evolved through trial and error with several different types of images. Rather than selecting an image that already clearly communicates a principle, I viewed each image through the lens of a 3D shot lighter and decided if it would be a candidate to receive notes about the particular principle if placed in a 3D lighting critique. This helped me narrow down the multitude of images and focus on images that would benefit from the application of the principle. As a shot lighter it was also an excellent exercise

to quickly analyze hundreds of images in terms of specific lighting fundamentals. There are also some technical issues that did not allow some images to be adapted. I'll discuss these in more detail in Chapter VI - Future Work.

III.2.1.3. Different Styles Must Be Represented

I felt it was important that the final selection of images would represent several different styles of famous 2D paintings. This was important to demonstrating that the principles of lighting and the 3D shot lighting critique process could be applied across different artists work and different artistic periods. This will make the research more interesting by allowing the principles to be applied to a variety of artists and styles, not to only one style of painting or one artist.

III.2.1.4. Personal Connection to the Images

Finally, it was important to me that I select images that I feel I connect with, feel drawn to, or have admired for a long time. This was important to my criteria from an outside viewer's perspective. If I can apply the fundamentals in a way that changes my viewpoint of images I already have a strong viewpoint on, then I will have a good indication other readers' viewpoints may be changed as well. This will allow me to have a better idea of the success of the thesis, and a more personal impact with the results.

III.2.2. Final Selections

Based on the above criteria, the images I selected for application of the fundamentals of lighting design and their corresponding fundamentals are:

III.2.2.1. Directing the Viewer's Eye – Auguste Renoir's *Bal du Moulin de la Galette* (19th Century Impressionism)



Figure 45. Auguste Renoir's *Bal du Moulin de la Galette* [31].

For Sharon's principle of Directing the Viewer's Eye, I selected a gorgeous Impressionist painting by Renoir seen in Figure 45. From my experience as a lighter this image has the visual complexity that makes it a perfect candidate for using lighting to direct the viewer's eye. It also happens to be one of my favorite Impressionist paintings, Pierre August Renoir's *Bal du moulin de la Galette*.

In production, some of the most challenging shots to direct a viewer's eye have the main character or characters set among a crowd. There can be hundreds of crowd characters and only one or two main characters that the viewer is expected to read. These images are full of visual complexity and it can be very challenging to ensure you don't visually lose track of the main characters among the crowd.

III.2.2.2. Creating Depth – Van Gogh's *Bedroom in Arles* (19th Century Dutch Post-Impressionism)



Figure 46. Van Gogh's *Bedroom in Arles* [21].

For demonstrating the principle of Creating Depth, I started by selecting an image that is well known, and where the lighting is very flat, Van Gogh's *Bedroom in Arles*, seen in Figure 46. The flat lighting makes it an especially good candidate for demonstrating the use of lighting to create depth in the image. There are also some

interesting color choices in this image, which we'll discuss in the application section. I had the pleasure of seeing this painting in Paris at the Musée d'Orsay and again when the traveling d'Orsay show came to San Francisco's de Young Museum. The colors and frenetic brushwork have always struck me as breathtaking to behold.

III.2.2.3. Enhancing Mood, Atmosphere, and Drama – Edgar Degas' *La Classe de Danse* (19th Century Impressionism)



Figure 47. Edgar Degas' *La Classe de Danse* [15].

In order to demonstrate the principle of Enhancing Mood, Atmosphere, and Drama, I decided to start with an image that initially has more of a high-key, generally

light-hearted feel and a subject matter that doesn't evoke a lot of intensity. The desired result is that by applying Sharon's principles to a very calm, non-dramatic image, it will be an opportunity to show how through lighting alone we can create drama and mystery in the image. The artwork I selected which fit the above criteria is also a beautiful example of Impressionist painting, Edgar Degas' *La Classe de Danse* (*The Dancing Class*), seen in Figure 47.

III.2.2.4. Revealing Character Personality and Situation - Grant Wood's *American Gothic* (20th Century American Art)



Figure 48. Grant Wood's *American Gothic* [37].

For the principle of Revealing Character Personality and Situation, it was important to me to select an image that was a portrait to ensure that a character was the

focus of the image. I also felt it was important to select a famous portrait so the viewer will already have a strong association and opinion of the character and personality in the image. This history allows for a greater impact once the lighting has been adjusted to reinvent or enhance that character's personality. What better choice for an impactful reimagining than to adjust the personality of Grant Wood's well-known portrait *American Gothic*, seen in Figure 48.

III.2.2.5. Conveying Time of Day and Season – Johannes Vermeer's *The Astronomer* (17th Century Dutch Golden Age)

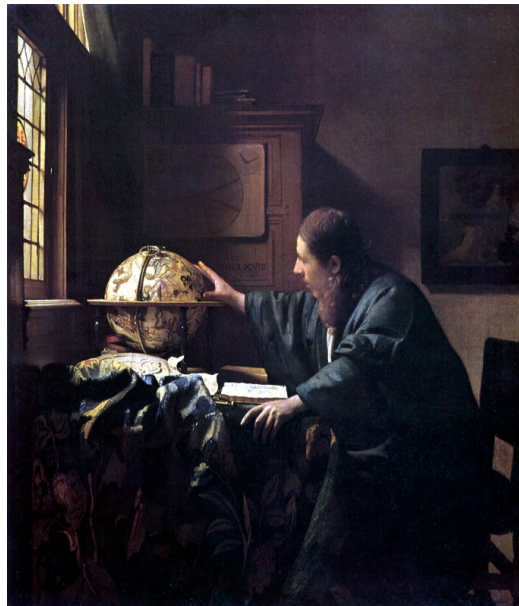


Figure 49. Johannes Vermeer's *The Astronomer* [34].

Time of day can be an important indicator of mood and atmosphere. We can use night to stimulate the viewer's imagination, the soft colors of sunset to create a romantic

feel, or the harsh light of midday to accentuate the heat found in a desert scene. For Conveying Time of Day and Season, I wanted to show a subtle example, where changing the time of day doesn't necessarily change the mood of the image, but rather, reinforces the intended mood and character in the scene. For that purpose, and because I am absolutely in awe of his sense of painting light, I selected Vermeer's *The Astronomer*, seen in Figure 49.

III.3. Method for Applying the 3D Production Shot Lighting Critique Process to the Selected 2D Works of Art

In order to apply the 3D production shot lighting critique process to the selected 2D works of art, I acted as Director and DP to create a narrative for each work of art. This narrative inspired the lighting notes for the particular principle in the way a 3D animated story inspires lighting notes for each shot. The paintings were then critiqued on their ability to demonstrate the intended lighting principle in the context of this narrative. Based on the notes from that critique process, I then digitally relit each image in Photoshop being certain that the resulting image could still be identified as an adaptation of the original image.

The resulting 2D images were judged on their ability to convey the intended principle. One of the techniques employed to judge the results was comparison to a selected reference image that, in my opinion, clearly conveyed the lighting principle. Another method was analysis of the histogram of value distribution in an image as an

indicator of contrast, thereby indicating lighting style. Finally, I also depended upon reasonable viewer observation as demonstration that the image conveyed the intended lighting principle, remained recognizable as an adaptation of the original, and created a distinct viewpoint on the image. The results of the application of relighting each image are subjective. It is up to the viewer to determine the success of the resulting image.

III.3.1. Directing the Viewer's Eye - Pierre-Auguste Renoir's Bal du moulin de la Galette

For Renoir's *Bal du moulin de la Galette*, I applied the lighting fundamental of Directing the Viewer's Eye in the context of a 3D shot lighting pipeline. I served as DP, in order to create the story points that informed the new focal point. Through application of the rules of Directing the Viewer's eye, I attempted to create a focal point in the image that supported the story as directed. If successful, the new image should create a clear focal point in the image that is different from the current focal point in order to create a unique viewpoint on this work of art. In order to prove success, I present it to the viewer for reasonable, subjective observation.

III.3.2. Creating Depth - Vincent van Gogh's Bedroom in Arles (3rd Version)

I applied the principle of Creating Depth to Van Gogh's *Bedroom in Arles*. Since the principle is about creating depth in the image with lighting, rather than a particular story, in this case, I served as DP for myself, creating notes for how to achieve the

desired depth. If successful, the new image should clearly demonstrate an increased sense of depth to the viewer. The results here are subjective. I relied on reasonable viewer observation and comparison to images that clearly communicated depth. The new image should give the viewer a greater perception of depth than the original image.

III.3.3. Enhancing Mood, Atmosphere, and Drama - Edgar Degas' La Classe de Danse

For Enhancing Mood, Atmosphere, and Drama I applied the 3D production shot lighting critique process to Edgar Degas' *La Classe de Danse*. For this principle it was necessary to create a story around the piece that enhanced the drama for our characters. I acted as DP in this case to create a story that informed the notes and the lighting of the new image. Based on my experience as a lighter, I selected an image to use as reference that already clearly communicated the intended mood. In order to demonstrate success, I relied on analysis of the contrast in the original image compared to the contrast in the new image to demonstrate that a different style of lighting had been created. To compare contrast, I compared the distribution of values from light to dark in the histogram of the images. I also compared the histogram values of the final image to that of the reference image to show through the relighting process that the image became closer to the reference image mood. I presented the resulting image to the viewer for reasonable, subjective observation. The new image should create a clear sense of

heightened emotion and drama that is different from the original image in order to create a unique viewpoint on this work of art.

III.3.4. Revealing Character Personality and Situation – Grant Wood’s American Gothic

For the principle of Revealing Character Personality and Situation I adjusted the lighting in Grant Wood’s famous portrait, *American Gothic*. I acted as DP to create a story that informed the notes and lighting of the new image. I selected reference material that is already lit to create the intended mood. Using the reference in conjunction with the rules of Revealing Character Personality and Situation I attempted to relight *American Gothic* in a way that enhances the viewer’s perception of the character’s personalities and creates a dramatized version of this well-known artwork. I relied on comparisons to the reference material as well as reasonable, subjective viewer observation for the results of this application.

III.3.5. Conveying Time of Day and Season - Johannes Vermeer’s The Astronomer

For this image, I applied the lighting fundamental Conveying Time of Day and Season in the context of a 3D shot lighting pipeline to Johannes Vermeer’s *The Astronomer*. I attempted to apply the rules of this principle to change the perceived time of day indicated by the lighting in the image. As viewers, we have extensive experience

perceiving different times of day. I presented the resulting image to the viewer for reasonable, subjective observation. If successful, the new image should clearly show through lighting alone that the image has changed from day to night creating a distinctly different viewpoint on the work.

CHAPTER IV

IMPLEMENTATION AND RESULTS

IV.1. Directing the Viewer's Eye– Pierre-Auguste Renoir's *Bal du Moulin de la Galette*



Figure 50. Auguste Renoir's *Bal du moulin de la Galette* [31].

IV.1.1. Notes

Sharon states, “The primary purpose of cinematic lighting is to support the story by contributing to the overall visual structure of the film...To that end, it is vital to understand the story point behind each shot...[3].” Imagining that Renoir’s painting in Figure 50 is a still frame from one of our shots, it will be important to understand the story happening in this image so we can determine the intended focal point.

In our shot kickoff the DP informs us that this is a love story about the couple circled below. This shot in particular is an establishing shot where it’s extremely important that we are able to read our main characters clearly and quickly. This shot also sets up an important emotional turning point in the film so it is critical that we read the happy expressions on their faces. The audience should feel that the couple is lost in their own world together, despite all of the action and excitement happening around them. It is also important that we get a sense of the rest of the dancehall without focusing on any other specific characters in the shot. Without changing the camera angle, set, characters, or animation, let’s apply the principle Directing the Viewer’s Eye to Renoir’s *Bal du moulin de la Galette* and digitally adjust the lighting in this painting in order to draw the audience’s eye to the intended focal point, seen in Figure 51.



Figure 51. The new intended focal point couple.

The primary objective of good lighting is to show the viewer where to look by enhancing what is important and minimizing what isn't [3]. To draw the viewer's eye to our focal couple, we must first understand where our eye is naturally drawn in the image and use lighting and shadow to downplay those competing areas.

From first glance, for me, the focal point of this image is the girl in the foreground with the striped dress. As shown in Figure 52, my eye pops first to her face, then up to the girl above her, then over to the gentlemen screen right, then across the image to the dancing couples midground in pink and blue and finally hits our main couple in the center of the image. After that, my eye wanders around the painting

picking up various details. Focal points can be subjective, however, viewer's eyes will wander around the painting in different ways.



Figure 52. Order of focal points for this artist.

From what we've already learned about Directing the Viewer's Eye, the girl in the foreground is likely drawing my eye more than the midground and background characters because she is larger in frame and the principle of emphasis through size states that larger objects naturally tend to attract more attention than smaller objects in an image [3]. She is also the only one wearing a striped garment with contrasting hues of orange and blue and through emphasis by contrast we know that the primary way to

create a point of emphasis in an image is by contrast. The eye is drawn to the point of contrast because the difference interrupts the perception of pattern in the scene [10]. She's also looking in the direction of the camera which we know from emphasis by recognition makes us more inclined to be drawn to her face because when humans see another human, we immediately try to discern whether we know the person or not [3]. Even if we don't recognize the person we'll continue to observe them to gain familiarity with them anyway [3]. "If two characters are standing side by side, one facing the camera and the other one facing away, we will spend more of our time looking at the character whose face we can see... [3]."

IV.1.2. Application

In order to downplay the strong focal point of the foreground characters and to make the hero couple pop out more in the frame, I reduced the foreground characters in value to create contrast between them and the main characters. Since I'm darkening the foreground characters down, I also took a look at the composition as a whole and applied the Gestaltist principle of unity through grouping to create a discernable group out of the foreground characters that will help begin to organize the busy composition as a whole. We know that the brain attempts to group objects close to each other into a larger unit, especially if they share the same size, shape, or value. In this case, the foreground objects share similar size and shape; I've also grouped them by value.

Using Photoshop on a masked adjustment layer of just the foreground characters, I reduced their exposure to bring down their value compared to the other characters. This is a start, but I don't just want them to feel darker, I want them to feel like they're in shadow. From production lighting, I know that when objects are in shadow colors tend to be more saturated, so I've adjusted the color balance to a slightly more saturated blue so that our foreground characters feel darker, but still integrated into the lighting in the painting. The result of these changes is seen in Figure 53. The hue contrast between the foreground characters' cool tint versus the warmer tint of our main characters will also help our main characters stand out more in the frame.



Figure 53. Creating a plane of light/shadow for foreground characters.

This is working much better for our main couple, however, the screen left dancing couples (focal points 4-5, Figure 52) are still drawing quite a bit of attention away from the intended focal point. Applying the same principle of reducing their value and grouping them by this value will help downplay their focal point. I want to make sure I'm keeping the whole image in mind as I make these adjustments. When dropping the midground characters down, if I used the same value adjustment I did to the foreground characters, I'm going to get one big dark spot across the image and the image will become very flat. If we think about maintaining a sense of depth in the image, let's consider the unity principle of planes, where we attempt to divide our world into planes of foreground and background receding in space from our point of view. This helps us quickly identify objects that are close and objects that are further away [10]. If I keep the value of this second grouping slightly brighter than our foreground characters, I'll be successfully creating multiple planes in the image which will maintain distinct organizational groups between the foreground and midground characters, as well as adding depth to the image.

With an adjustment mask for just the screen left midground characters, I brought down the exposure and slightly adjusted their color balance to make them feel like they're in shadow. The adjustments to value and color were similar to what was done for the foreground characters, but less extreme in both cases. Figure 54 shows the image that results from grouping the midground characters by value, but keeping that value slightly brighter than the foreground characters to maintain distinct planes of light in the image. I'm almost there, but if I'm looking critically at the image, by reducing the value

of the previous focal points, I've now created a new focal point, the man's hat circled in red in Figure 55.



Figure 54. Creating plane of light/shadow for midground characters.



Figure 55. New focal point created by downplaying other focal points.

In the above example, the hat is now one of the largest, most contrasting values in the image and thus has the most emphasis, creating a new focal point and still drawing our eye away from our main characters. To solve this problem, I applied the principles of grouping by value and planes again to organize the image into another plane of light and downplay the contrast in the bright yellow hat. Using a similar exposure and color balance trick as I did for our other groups, Figure 56 shows the result of bringing down the screen right group of characters.



Figure 56. Creating plane of light for screen right grouping of characters.

Now our happy couple is starting to pop out of the frame. The only issue remaining is that they're blending into the busy background just a bit. I can apply the planes of light and grouping principle to the far background of an image as well as to the foreground. To accomplish this, I applied the exposure and color balance technique in Photoshop to darken down the background behind the main couple. This popped them out just a bit more and solidified them as the intended focal point of the scene. The final adjusted image is in Figure 57.



Figure 57. Final relit version of Renoir's *Bal du moulin de la Galette*.

IV.1.3. Results

By understanding the intended story point of the image, the dancing couple in the center of the frame, I was able to apply the fundamental of Directing the Viewer's Eye to analyze this visually complex image and determine which areas of emphasis were competing with the intended focal point and why. I then used the principle of Directing the Viewer's Eye again and through careful shadow placement, organized the image into

groups of value and planes of light. Interestingly, all of this was accomplished without changing anything about the lighting of our main characters - I only adjusted the value and hue of the groups around them. The result is a well-organized image that creates a story not about the woman in the striped dress, or the other characters in the foreground, not about the dancers to the screen left of the image, or the people in line screen right of the image; this newly created image clearly directs the viewer's eye to the couple in the center of the image.

From a production sense, I accomplished the notes in that we can quickly read the couple, we read the happy expressions on their faces, and we get a sense of the location and excitement without focusing on any other specific characters in the shot. Using the principle of Directing the Viewer's Eye I have successfully digitally relit Pierre August Renoir's *Bal du moulin de la Galette* and changed the intended focal point of the scene, thereby providing a unique viewpoint on this well-known artwork.

IV.2. Creating Depth – Vincent van Gogh’s *Bedroom in Arles* (3rd Version)



Figure 58. Van Gogh’s *Bedroom in Arles* [21].

One of the notes we hear most often in shot lighting reviews is that our images are looking flat, or lacking depth. Depth is an incredibly important part of lighting to keep in mind when approaching a shot because as we discussed earlier “Any feeling of depth, space, or volume achieved (in a two-dimensional medium) is merely an illusion” [3]. This is particularly important in production because enhancing depth enhances the visual interest of the image, drawing the viewer into the scene and thus the story.

For this fundamental, I applied the 3D shot lighting critique process to Van Gogh's *Bedroom in Arles*, Figure 58. Since the principle is about creating depth in the image, rather than a story, in this case, I served as DP creating notes for how to achieve the desired depth. If successful, the new image should clearly demonstrate an increased sense of depth to the viewer. In order to prove success, I use image analysis techniques to determine the amount of depth that exists in the original image as opposed to the amount that exists in the final image. I also demonstrate that the depth is achieved through lighting adjustments alone by showing the final image independent of color. If successful, the new image should create a clear sense of depth that is different from the current amount of depth in order to create a unique viewpoint on this work of art.

IV.2.1. Notes

If Van Gogh brought this image to walkthroughs, the first step would be to examine which light sources are in the room that he could use to bring more depth and life to the image. The most obvious source is the window in the center of the painting. The DP informs him that this window is where the key direction should come from in this daytime scene. She would also like to see some reflections in the floor and a bit of bloom over the window.

Certain staging and lighting techniques cause an image to appear more flat, while other techniques will enhance depth. Unfortunately, we can't do anything about the layout or staging of the scene. If this were a production, by this point the layout and set

dressing would have already been finalized. So, we'll take a look at the Creating Depth principles to understand why the lighting in the image is feeling so flat and what we can do to create more depth in the image.

We know that depth in an image is enhanced if the foreground and background objects have value and color separation. Immediately I can see that there is very obvious color separation, the more near objects are much warmer and the background objects are much cooler. This is perfect because color contrast with foreground and background elements will increase the feeling of depth in an image particularly when they are opposite each other on the color wheel, as seen in Figure 59. Additionally, Van Gogh is helping to create chromatic depth because warm colors naturally tend to feel more near than cooler colors.

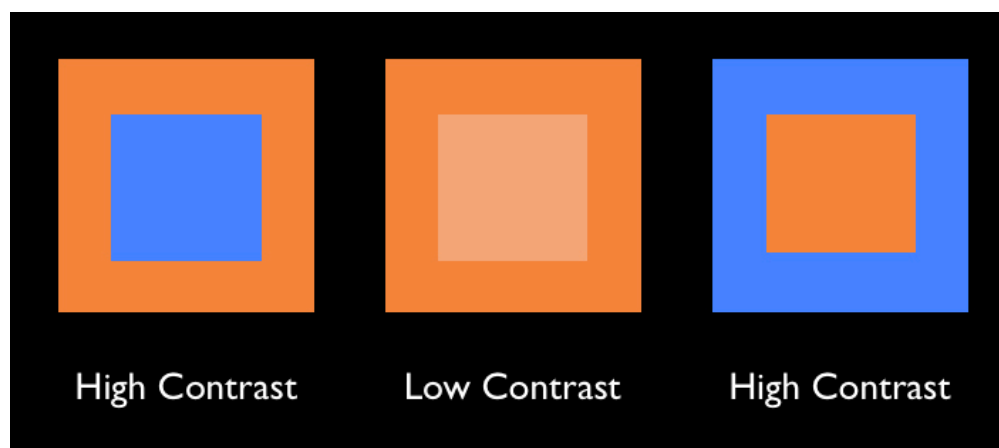


Figure 59. This image illustrates how depth perception is affected by color. The image on the left appears to be an orange frame with a blue hole in the middle. The image on the right appears to be an orange box on top of a larger blue square [4].

To visually demonstrate that color contrast is creating depth in the image, I adjusted the color balance of the image by pulling the warm hues to cool. In Figure 60, you can see how the depth Van Gogh has achieved through color contrast has been sucked out of the original image (Figure 61).



Figure 60. All colors pushed to cool to remove depth achieved by color contrast.



Figure 61. Original *Bedroom in Arles*.

So we know we've got color on our side, but we also know the image has to have value separation as well to enhance depth. A trick that lighters often use to examine depth in their images is to look at only the value independent of color. Figure 62 shows the value only for *Bedroom in Arles*.



Figure 62. Value only version of *Bedroom in Arles*.

From the above example, we can tell that Van Gogh has painted a value progression where the foreground objects are generally darker in value and the background objects are generally brighter in value. If there already exists color and value contrast between foreground and background objects, why is this image still feeling flat?

From the principle of Creating Depth we know that just as value contrast creates the illusion of depth between foreground and background objects, value shifts across the surface of an object also enhance the form. In Van Gogh's image we have color and value contrast between the foreground and the background, but the objects themselves still feel flat because there is no tonal shift across each object. Van Gogh's use of large flat planes of color and value in *Bedroom in Arles* is reminiscent to me of Cimabue's

similar use of color and value in his *Madonna in Majesty* (c. 1285). Figure 63 shows the original version of the two images. Figure 64 shows a value only version of the images.

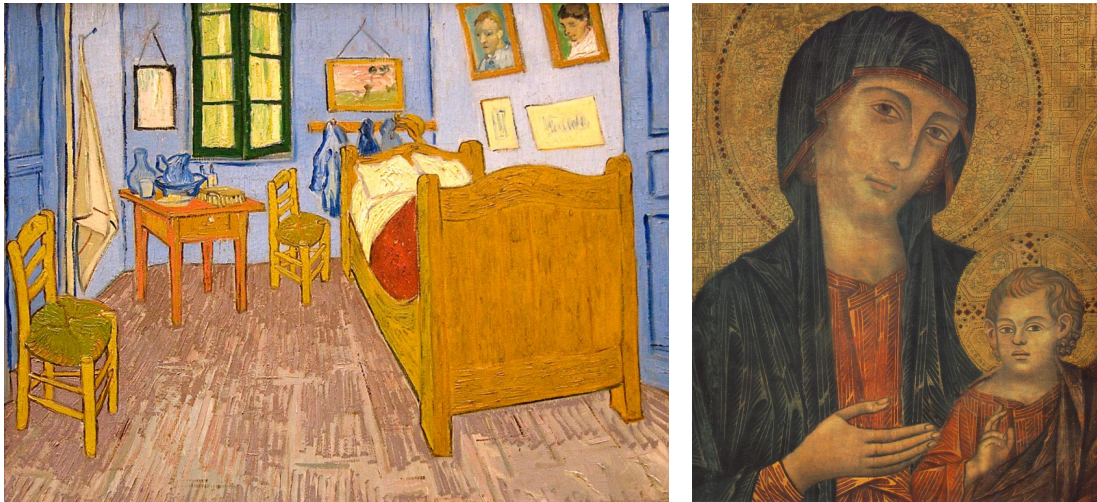


Figure 63. Original *Bedroom in Arles* and *Madonna in Majesty* crop, Cimabue, c. 1285.



Figure 64. Value only representation of *Bedroom in Arles* and *Madonna in Majesty* crop, Cimabue, c. 1285.

In both images above, there is very little indication of light direction because of the lack of local contrast across the surfaces. Everything feels fairly evenly illuminated. “In lighting computer graphics scenes, we can apply Leonardo’s concept of enhanced local value contrast to create enhanced volume in our subjects by adjusting the light position and quality.” The object’s in Van Gogh’s bedroom right now are like the orange that is frontally lit - the lighting is suppressing the form and texture because there is no indication of light direction since there is no value change across the surfaces of the objects, seen in Figure 65.

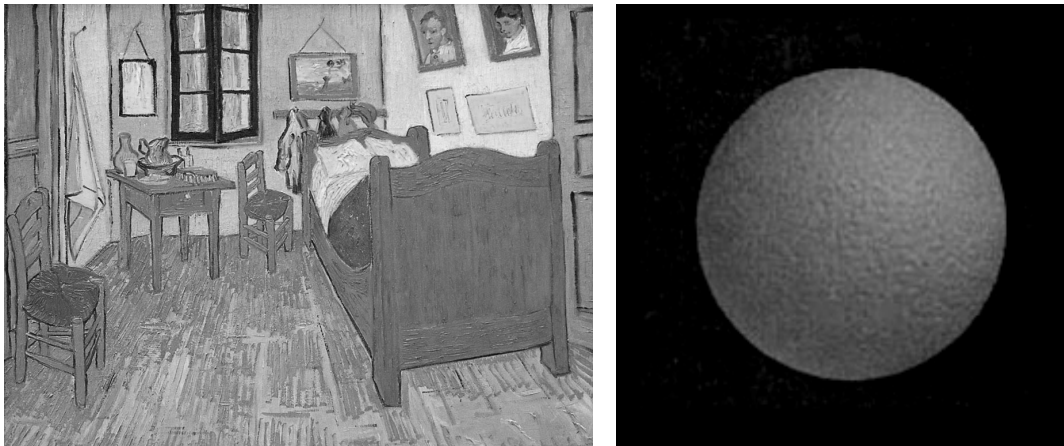


Figure 65. Value only representation of *Bedroom in Arles* and flatly lit orange.

IV.2.2. Application

Now that I understand what the problem is, I can address the DP’s notes to create a very clear key light that is coming from the window and illuminating the scene. To

give an indication of key light direction, we know that we need to have value changes across objects, some areas will go brighter, and other areas will go darker. In Photoshop, I painted in bright values by duplicating the image and using an adjustment layer to turn up the exposure on the image. I then went in and painted out the adjustment layer mask for areas where the key light should be brighter if it was streaming in the window. I did a similar process for the shadows. I duplicated the original image, turned down the exposure, and painted the mask layer to create areas that would naturally be in shadow. Figures 66 and 67 show the results of those two steps.



Figure 66. Painting in bright values.

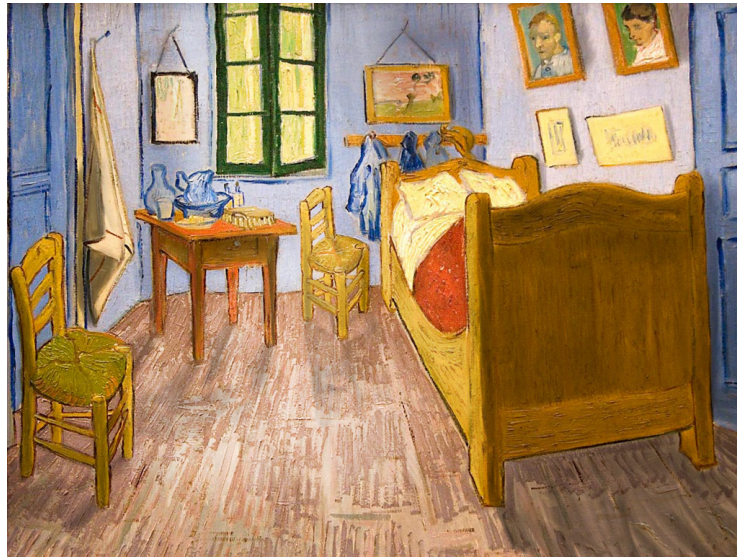


Figure 67. Painting in dark values.

From the above images, we can see that we're starting to get some local value shifts across the surface of objects by indicating a clear light direction in the image. I've brightened and darkened value, but when we light, we also need to think about saturation that happens with value. If you look at the above image, particularly in the shadow cast from the bed onto the floor you can see how gray the darks are going. This is something that we keep an eye out for as production lighters. When light is darkened, the resulting color should become more saturated. When light is brightened, the resulting color should be less saturated. I adjusted the saturation in Photoshop using the same adjustment masks I used for painting in the exposure areas. The result, in Figure 68, has less saturated brights, more saturated darks and is a much more pleasing image.



Figure 68. Adding color saturation in dark values and color desaturation in bright values.

The final step is to address the last of the DP notes, to add some reflection onto the floor from the window and to add some bloom over the window. Duplicating the image and flipping it vertically then reducing the opacity adds a slight reflection of the room onto the floor. The window bloom was created using a layer of selectively painted, blurred bright values screened over the window. Figure 69 shows the newly reimagined Van Gogh's *Bedroom in Arles*.



Figure 69. Enhanced depth *Bedroom in Arles*.

IV.2.3. Results

Let's revisit some of the image analysis techniques we started with, just to be certain I've accomplished the goal of creating depth in this image. Taking color out of the equation, let's check that we now have local value shifts across the image. Compare Figure 65, the value only original image, with Figure 70, the value only relit image. These are presented along with the value examples of the orange. Careful visual analysis of the images indicates that the digital relighting has created more three-

dimensional form and texture across the surfaces of the objects in Van Gogh's bedroom.

The new image more closely resembles the orange that was lit to enhance its form.

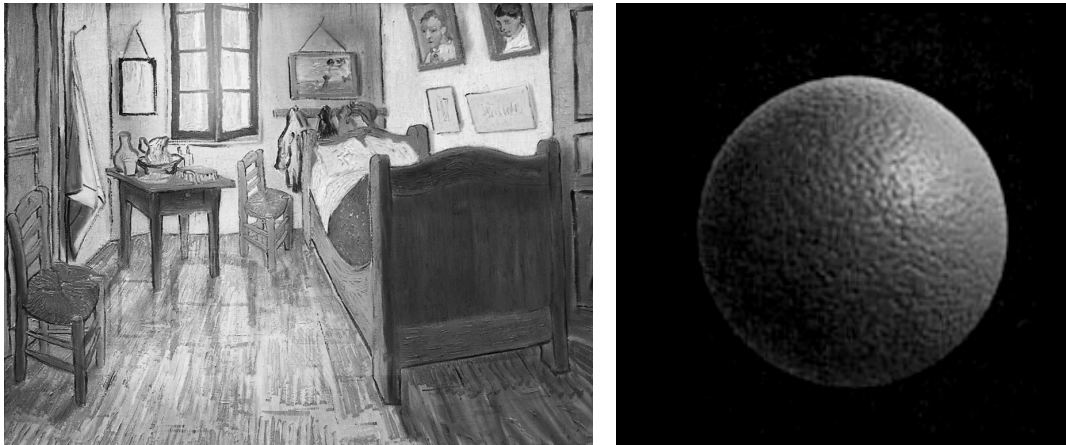


Figure 70. Value only – New *Bedroom in Arles* and orange lit to enhance depth.

There's one more test I can do just to be certain the value shifts are creating perceived depth, independent of the color choices in the image. Using the new relit version, I can push all of the colors cool with a color balance adjustment and see if we're still getting depth in the image. Figures 71 and 72 show a reduced color contrast comparison of the original image with the new image.



Figure 71. Original *Bedroom in Arles* - All colors pushed to cool to remove depth achieved by color contrast.



Figure 72. New *Bedroom in Arles* - All colors pushed to cool to remove depth achieved by color contrast.

Analyzing Van Gogh's *Bedroom in Arles* with the principles of Creating Depth shows even when color contrast and foreground to background value contrast are already working in an image, greater depth can be achieved if the form of objects is carved out by indicating light direction using local value contrast.

IV.3. Enhancing Mood, Atmosphere, and Drama – Edgar Degas' *La Classe de Danse (The Dancing Class)*



Figure 73. Edgar Degas' *La Classe de Danse* [15].

IV.3.1 Notes

The principle of Enhancing Mood, Atmosphere, and Drama is incredibly important to keep in mind for any lighter. Even if you are directing the viewer's eye to the intended point and your image has sufficient depth, the audience will have a hard time emotionally connecting with the story if you're not communicating the mood of the scene. Let's say that Degas brings *La Classe de Danse*, Figure 73, to walkthroughs with the DP and she explains to him that this is one of the highest points of tension in the film. The tension is between the main characters, the dancer in the center of the frame and the dance instructor. The purpose of this shot is to make the viewer feel extremely uneasy about what is going to happen next, in particular the response from the instructor's character. The dancer should be the focal point of the image, it's important that we read her as a pure, innocent character in this situation, at the mercy of the more shadowy emotions of the instructor. The other dancers are unimportant in the image, they should only be hinted at and they should not feel like they are sympathetic to the dancer's plight. Figure 74 shows a quick representation of these general notes.



Figure 74. Quick visual to communicate the intended notes for the scene.

Now that we have the notes, let's analyze what we have to start with so we can figure out how to increase the drama in this image to accomplish the notes. From what we learned about the principle of Enhancing Mood, Atmosphere, and Drama we know that the character and mood of an image is dramatically affected by the range of tonal values from light to dark and by their distribution within the frame. We can probably tell just from looking at the image that there is a wide range of value, but let's use our digital image tools to check the value contrast by looking at only the value in the image and checking the histogram (distribution function) of the values, presented in Figure 75.

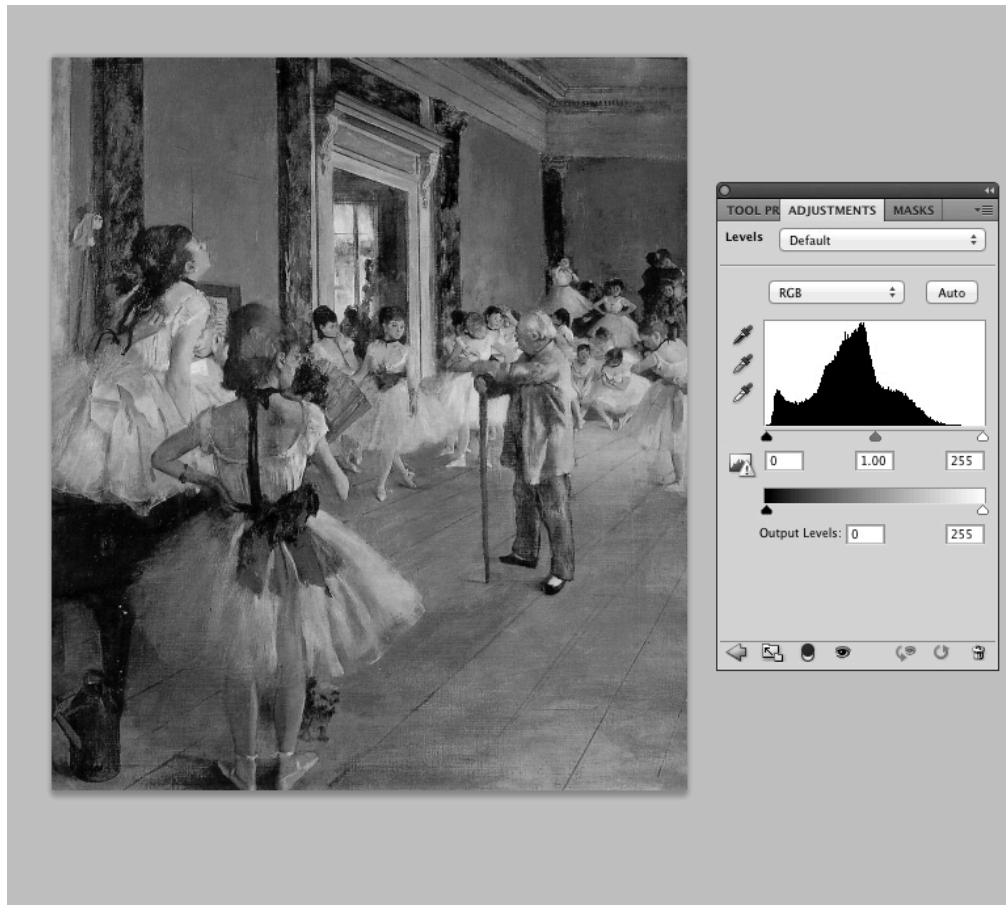


Figure 75. Value only version of *La Classe de Danse* with the histogram of the image.

We can see from the image above and from looking at the histogram that right now in the image there are some dark darks, not a lot of super bright whites, and a lot of gray values in between. This is definitely a very high-key image because the key-to-fill ratio is low and the overall value contrast is low. From the Enhancing Mood, Atmosphere, and Drama section on style we know that high-key images are typically associated with comedies and other light-hearted stories. We also know that this style creates an image that has little suspense because the audience can clearly see everything

and there is little left to the imagination. Additionally, we know that a very low contrast scene will convey bleakness or calmness, not at all the intended mood of our scene.

This indicates that for the image to have more drama we want to relight it to create a scene that has very little fill light and lots of areas of shadow. We want to only hint at the details in the image, leaving the viewer to fill in the visual gaps. In addition to creating a more moody feel, this increased contrast range will have a more graphic quality and convey more of a sense of energy and unrest.

In addition to the overall value contrast, we also know that the quality of light, how hard or soft and what color it is, will dramatically affect the mood of the scene. In the image right now, if we look at the shadows cast by the dancers and the instructor, we can see that they are short and relatively blurred, indicating that the light quality is soft. As discussed earlier, soft lighting tends to be romantic and inviting, like Hollywood glamour lighting. When deciding on the key light quality, in order to enhance the drama in the scene, we'll likely want to create a more hard light source because the harshness of the shadows will make the image feel colder and less visually pleasant than soft light, more closely matching our intended mood for the scene.

Another aspect of the quality of light is what color the light is. We know that colors in the red-yellow spectrum tend to elicit excitement from the viewer and increased energy. In our image right now, we've got desaturated warm colors in the floor and a few pops of saturated reds in the screen left dancer's hair bow and fan. We've also got quite a bit of cooler shades of green on the walls and some of the dancer's bows. We

could decide to push the color of our lighting a bit more warm overall to evoke more excitement from the viewer.

Another important part of Enhancing Mood, Atmosphere, and Drama is the motivation of the light source. Right now, the light source appears to be coming from screen right, perhaps from an off-screen window. In this case, the only practical source in the scene is the window in the far background, but since we want to be certain to read our main dancer, we don't want to backlight her, so that would not be a good choice for the key light direction. This means we can choose an off-screen key direction. This is good because it gives us some flexibility with where we decide to place our key light. When choosing the key direction it's important to keep in mind that we want the dancer in the center of frame to be the focal point and the dance instructor to be somewhat focal, but mysterious.

When working as a CG artist, one of the most important parts of our jobs whether we work in lighting, modeling, effects, animation, set dressing, or any creative department, is to gather reference material. When your Director or DP gives you notes, it's important to find reference images or video clips to analyze, to ensure you're creating what you actually see, not just what you think you see.

For this application, I selected a reference image from Gerard van Honthorst entitled *The Matchmaker*, seen in Figure 76. I selected this image as reference because it evokes a lot of the emotion we're attempting to convey. It's a very low-key, high contrast image that evokes a sense of excitement and drama. It makes the viewer feel uneasy since we can't see all of the details of the characters. Comparing *The*

Matchmaker to *La Classe de Danse* it's clear there is a lot of work to do to relight our Degas in a way that evokes as much excitement and emotion.



Figure 76. Honthorst's *The Matchmaker* – selected image for enhanced mood reference [30].

IV.3.2. Application

One of the first things I need to do to increase the drama in this scene is to select a key direction and adjust the value contrast and key quality in the image. We want to clearly see our main dancer while at the same time keeping the instructor mysterious. So I know I need to select a key position that highlights her and keeps him in shadowy detail. That should begin to evoke the desired emotional response to each character. By

analyzing *The Matchmaker*, we can see how the edges of the image drop off to almost nothing, and the characters in the foreground are only slightly rim lit, hinting at their details but providing very little information about them. We also know we want hard shadows and the dancer to be the focal point.

To accomplish all of these goals, I selected a key light direction that allowed the shadows of the instructor to lead the viewer's eye directly to the focal dancer. Painting in some areas of shadow selectively in Photoshop to indicate the selected key light direction results in the image in Figure 77. Comparing it to the original, we can already see that the increased contrast and hard key light quality is beginning to evoke mood and mystery in the image. Additionally, using the instructor's shadow to direct the focal point toward our dancer is drawing our eye directly to her in the frame.



Figure 77. Comparison of original image and first step of notes - selecting key light direction and contrast range.

The next thing I noticed from analyzing the reference image is that the bright values are much brighter in the Honthorst than in the Degas. I created an exposure adjustment layer in Photoshop to bring up all of the bright values. Then I painted the layer mask to reveal the brights selectively where I wanted them to be in the image. This increased contrast gives the viewer a greater sense of excitement in the scene.



Figure 78. Result of bringing up the bright values in the image.

Analyzing Figure 78 we can see that we're getting there, but the instructor still doesn't feel quite mysterious enough, and the overall drama feels like it could be pushed further. Careful analysis of the contrast levels may help inform the next step in the relighting process. Let's take a look at the value in the Degas, Figure 79, compared to the value of our reference image, Figure 80.



Figure 79. Value only representation of original image with histogram.



Figure 80. Value only representation of reference image with histogram.

Looking at our value histograms we can see that we still have a lot more middle gray values in our image than in the reference image. To increase the contrast even further, I added a curve adjustment to the image and brought down the curve for just the middle gray values, seen in Figure 81. Analyzing the result of this contrast shift in Figure 82, we can see that this gets us much closer to the reference image value contrast levels and visually creates more drama in the image.



Figure 81. Resulting value only image and new histogram after middle gray values have been brought down.



Figure 82. Comparison of reducing the middle gray values in the image.

We discussed how extensively the color of light affects our emotional involvement in a scene. By shifting the color balance a bit to red, I added the final touch of drama to our Degas. Figure 83 shows the final relit image compared to our original image.



Figure 83. Comparison of original *La Classe de Danse* with enhanced mood *La Classe de Danse*.

IV.3.3. Results

In order to evaluate the results of the relighting, let's compare our final relit Degas to our reference Honthorst. In Figure 84, by visually comparing the two images we can see that our relit *La Classe de Danse* now evokes a similar mood and mystery to *The Matchmaker*. The dramatically increased value contrast in the image creates large patches of dark shadows, increasing the mysteriousness since the viewer cannot see everything that is happening in the scene.



Figure 84. Comparison of enhanced mood *La Classe de Danse* and reference image *The Matchmaker*.

As seen in Figure 84, the choice of key light quality and position allows the long, sharp shadows to lead the viewer's eye directly to our intended focal point of the main dancer. It additionally accomplishes the note to create a heightened sense of tension between the two main characters by connecting them in space through careful shadow

placement. Placing the key light where we did also enables the viewer to clearly see the main dancer's face, indicating that her intentions are innocent; she has nothing to hide. At the same time, our key light placement enabled us to keep the face of the instructor partially obscured, so we don't have a clear idea of what he's thinking or of what his intentions are. Had we backlit our main dancer and allowed the light to hit the front of our instructor's face, we would likely have a different read on the two character's personalities entirely. Keeping the dancers in the foreground barely rim lit indicates their shape without revealing anything about their motivations and without distracting from the tension in the scene. Applying the principles of Enhanced Mood, Atmosphere, and Drama to Degas' *La Classe de Danse* enabled us to take a scene and by manipulating the lighting alone, change the emotional impact of the entire scene.

IV.4. Revealing Character Personality and Situation – Grant Wood’s *American Gothic*



Figure 85. Grant Wood’s *American Gothic* [37].

IV.4.1. Notes

Grant Wood brings his classic portrait *American Gothic* (Figure 85) to walkthroughs with the DP. She explains that this image should introduce the characters as spooky and foreboding. They should feel disconnected from the environment. The characters should be the obvious focal point with the majority of the attention being drawn to their faces so the audience clearly reads their stern expressions. The buildings

in the background should merely exist as a backdrop and not call too much attention in the scene. The bright sky will need to be downplayed and made much darker so the mood of the scene is more foreboding. The character design, characters' expressions, props, and location are already helping the image to feel creepy, we need to think about how we can push that feeling even further with lighting.

IV.4.2. Application

We learned in section II.4. “The quality, color, and direction of light can give the audience impressions about the personality or character of the subject. They can also say something about the dramatic situation or emotional state of mind, in which the subject currently finds himself [3].” For this lighting principle, we’ll select a reference image that conveys the intended mood of the resulting scene.



Figure 86. Reference image of Anton Ego lighting from the Disney/Pixar film *Ratatouille* [9].

The selected reference image is from the film *Ratatouille*, seen in Figure 86. It depicts the main antagonist, Anton Ego, sitting at his desk. From the reference image we can see that Ego feels spooky and foreboding. Similarly to *American Gothic*, the character design, character expression, props, and location are all contributing to the mood. In this case, however, the lighting is reinforcing his creepy personality. One of the first things we notice is that the overall style is low-key with lots of areas of shadow and high contrast. This creates an enhanced feeling of mood and mystery about Ego's personality in the scene.

The key light direction and color are also contributing to Ego's character personality. Placing the key light direction in a three-quarters backlit position lets most of his face and body drop off into shadow. The choice of key color is also contributing to the mood. The very bright, desaturated key color pulls the warmth out of his skin tone. We tend to associate health and vitality with warmer skin tones so this choice of desaturated key gives his skin an unhealthy and unnatural glow making him feel sickly and pale.

The fill color on Ego is also very cool giving his skin a creepy glow. The choice of a cool fill color is extremely interesting. Fill color typically mimics the color of light that has bounced around in the scene. In this scene, Anton is sitting in an extremely warm environment. The desk behind him is a rich warm color and the chair he's sitting on is warm. Using a cool fill color on Ego in a warm environment gives him a subtle, unnatural feel. It's not immediately obvious what is inconsistent with the lighting between Ego and his environment, but it gives the viewer an uneasy feeling about his character. In Figure 87, if we look at only the blue color contribution in the image, called the blue channel, it is easy to see that the cooler colors dominate on Ego and are not very present on the background. In Figure 88, if we look at the contribution of the reds in the image, called the red channel, it is easy to see that warmer colors are found throughout the entire image except on Ego's dark clothing.



Figure 87. Image showing the blue channel.



Figure 88. Image showing the red channel.

Looking at the bottom of Ego's nose we can also see that he has a saturated red bounce light. As discussed in section II.4.3, hard under lighting is classically used to signify an evil villain because it is an unnatural angle for a light source. Choosing a saturated red bounce light also pushes the viewer's emotional response to color giving the sense that Ego's personality is dangerous.

To begin relighting *American Gothic* in the style of the reference image, the first step was to begin creating mystery by adjusting the overall contrast in the scene. We know that the reference image of Ego has a low-key style where *American Gothic* is initially a very high-key image. There are not a lot of areas of shadow and little is left to the viewer's imagination. To determine which areas should be in shadow I selected a key light position similar to the reference image, in a three-quarters backlit position. As seen in the image of Ego, this position allows the front of the body to be largely shrouded in shadow. To create areas of shadow I created an adjustment layer in Photoshop with a dramatically decreased exposure and painted in a mask that revealed the decreased areas of exposure only where I wanted the shadows to be. I also darkened down the background in a similar way, decreasing the exposure only slightly. You can see the results of this in Figure 89.

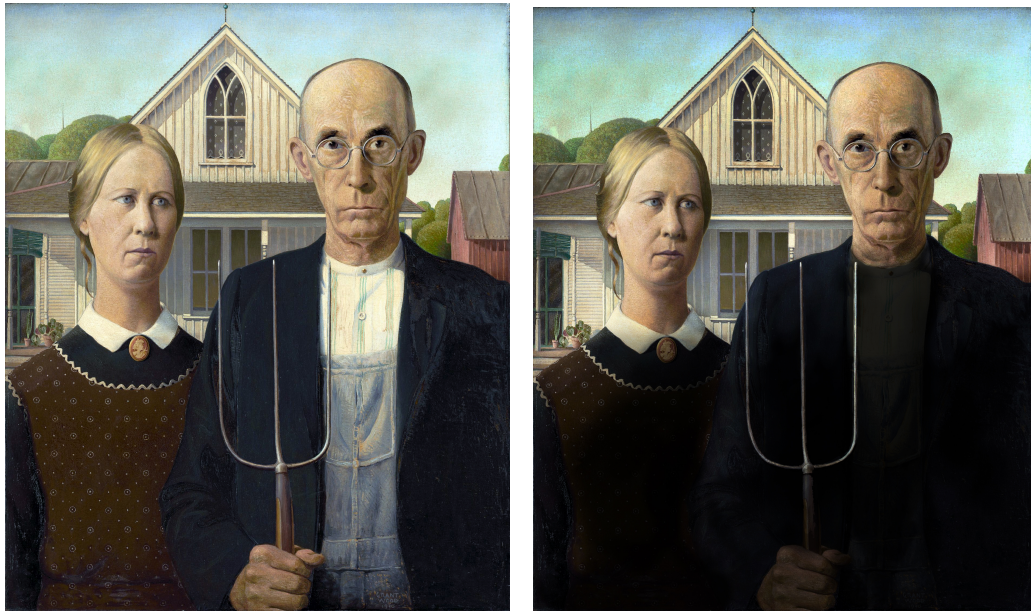


Figure 89. Comparison of original image to the first step of notes – increasing contrast in the image and beginning to indicate $\frac{3}{4}$ backlit key position by painting areas of shadow.

I've added the areas of shadow, the next step will be to do a similar process for the bright values in the image. Analyzing the reference image, the key light on Anton is coming from a three-quarters back position, is very high intensity, and desaturated. To create a key light in American Gothic, I created an adjustment layer in Photoshop and increased the exposure dramatically, then painted the layer mask so that the exposure adjustment was visible only where I wanted the key light to affect the characters, seen in Figure 90.



Figure 90. Painting in bright values for the $\frac{3}{4}$ backlit key light.

The next step in the relighting process was to create the strong color contrast between foreground and background elements that was noted in the reference image. The foreground characters need to be pushed towards cool and desaturated. The background needs to be pushed towards red and saturated. This will create the creepy, discontinuous feel of the lighting on the main characters. To warm up the background, in Photoshop I applied a warming photo filter with a saturated sepia tone to only the background. To cool down the characters I applied a cool photo filter on them.



Figure 91. Warming up the background and cooling off the foreground.

From Figure 91 we can see that the odd color contrast is beginning to feel like the reference image, but it looks like the contrast and saturation could be pushed quite a bit further. Greater overall saturation in the image will tend to cause the viewer to feel more tension and excitement. I added an overall saturation to the image, applying it much more strongly to the background using the reference image of Ego as a guide. I also increased the contrast of the image to push the difference between the bright key and dark areas of shadow. The results of these changes are seen in Figure 92.



Figure 92. Pushing contrast and saturation.

The final step was to add the warm bounce light to the characters to give them an under lit, villainous appearance. For this step, I created a color balance adjustment layer and shifted the mid and highlights towards red. I then painted the adjustment mask so the red showed up only on the planes of their faces that are pointing down, where bounce light would hit them. Figure 93 shows the newly reimagined *American Gothic*.



Figure 93. Adding a saturated red light from underneath to push the unnatural feel of the lighting.

IV.4.3. Results



Figure 94. Comparison of original *American Gothic* with Enhanced Character Personality and Situation *American Gothic*.

By visually comparing the two images in Figure 94 we can see that our reinterpreted *American Gothic* evokes a much more ominous feeling about the characters' personalities than the original image. The discontinuity of the light intensity and color between the characters and the background evokes a strange mood because the lighting doesn't look natural. Placing the foreground characters in a cool fill light and the background in a very warm, saturated light, we created visual tension in the scene. The cool skin tones made the characters feel pale and sickly compared to the warmer tones in the original image. Choosing a three-quarters backlit key position enabled me to place

the front of the characters in shadow, enhancing the mystery in the image. Additionally, increasing the overall contrast of the image created a low-key scene, full of shadows that enhanced the drama and personality of the main characters.



Figure 95. Comparison of reference image from *Ratatouille* with Enhanced Character Personality and Situation *American Gothic*.

Comparing the relit version of *American Gothic* to the reference image of Anton Ego in Figure 95, we can see that the new version evokes a similar foreboding, spooky quality to the reference image. The harsh, desaturated key, cool fill, and warm bounce create a lighting setup that feels completely unnatural. Placing cool skin tones in a warm environment further pushes the color contrast and uneasy quality of the scene.

There's one more test we can do to be certain the cool colors in the scene are focused on the foreground characters. In Figure 96, if we look at only the blue color

channel, it is easy to see that the cooler colors dominate on our main characters and are not very present on the background similar to the reference image. If we look at the contribution of the red channel in Figure 97, it's easy to see that warmer colors are found throughout the entire image except on the characters' dark clothing.

We have accomplished the DP notes to give the characters a spooky and foreboding feeling. The color and value contrast disconnects them from the environment and draws the viewer's focal point directly to their faces. The buildings in the background do not draw too much attention, and the bright sky has been downplayed to create a dark, unnatural mood. Applying the principles of Conveying Character Personality and Situation to Grant Wood's *American Gothic* demonstrated the effects of breaking the natural rules of light to enhance tension in a scene. Even when the character design, character expressions, props, and location are already helping the image to feel creepy, careful selection of light quality, color, and direction, can enhance a character's personality.

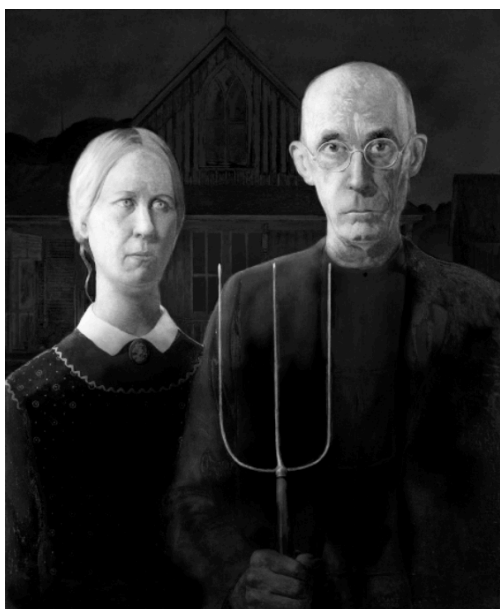


Figure 96. Comparing the blue channel of the reference with the blue channel of the relit *American Gothic*.



Figure 97. Comparing the red channel of the reference with the red channel of the relit *American Gothic*.

IV.5. Conveying Time of Day and Season– Johannes Vermeer's *The Astronomer*

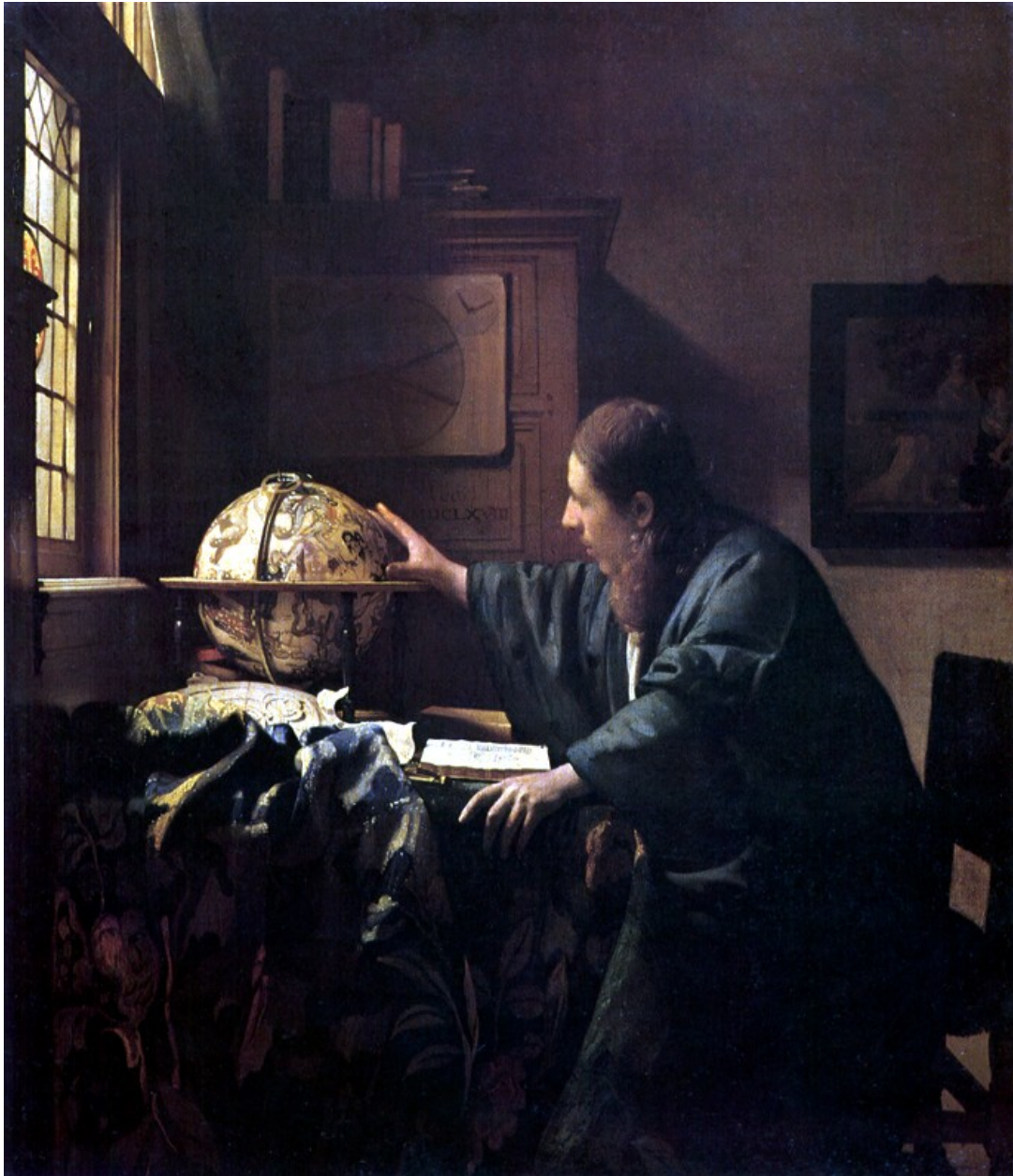


Figure 98. Johannes Vermeer's *The Astronomer* [34].

IV.5.1. Notes

Vermeer's depiction of light is so exceptional, it's hard to imagine him ever getting any notes. In Figure 98, *The Astronomer*, we can see that he's already successfully applying the fundamentals of lighting we've already discussed; the image has depth, he's directing the viewer's eye, and there's a sense of mood and atmosphere that is softened by the delicate treatment of light across our character's face, making it an appealing and intriguing image. The DP takes a look at this image and while impressive, she asks Vermeer to stop for a second and think about this character. Who is this character really and what is he doing in this scene? From the title of the piece and the objects on his desk we know that he is an astronomer who appears to be hard at work.

What if we changed the time of day to reinforce our character of the astronomer by setting this image at night? The DP would like the window to remain the practical light source in the scene, but she would like it to be moonlit instead of sunlit. The desired result is that through adjusting the lighting from day to night we will have an intensified sense of our character and story because he is an astronomer. The intention is that setting the piece at night, rather than during the day, will create a stronger connection between him and his work with the stars and thereby create a more powerful image.

IV.5.2. Application

We have our story notes, now we will adjust the lighting to transform this image from day to night. We know the most important indicators of time of day are overall key-to-fill ratio, shadow length and density, and the color of the light sources in the scene. Often in lighting we begin by analyzing shadows since their contrast is easy to see and can help us draw conclusions quickly. In this case, the shadows in the image are long and dense. This tells us that it's definitely not noon, so it's likely either afternoon or morning when the sun is further down in the sky. We know the scene is not already moonlit because of the warm, saturated color of the light source.

In order to create a moonlit scene, we should start by adjusting the color. As discussed in section II.5.5, we perceive moonlight as being cool because the rods in our retina which are light sensitive do not distinguish colors very well and are much more sensitive to blue and green wavelengths. Moonlight also tends to fall off quickly so we'll want to adjust some of our value curves. Luckily, since the overall contrast key-to-fill ratio is already high and the shadows are long and dense, it shouldn't be too difficult to turn this into a moonlit scene.



Figure 99. Comparison pulling yellow and reds toward blue and cyan.

The first step to turn day into night was to adjust the overall color balance of the image by pulling the warm colors towards cool, as seen in Figure 99. Next I checked the histogram to determine the overall value contrast of the image, seen in Figure 100. While certainly pushed, the light still feels like it's wrapping around the character and objects more than moonlight would. Moonlight tends to fall off quite quickly since it is dim and there is very little fill in a night scene. To give the feeling of the light falling off quickly, I wanted to preserve the bright values and dark values and just bring down the middle gray values. To do this, I used a curve adjustment on the image pulling down the middle gray values. This gave me the new value contrast seen in Figure 100 and the new image in Figure 101.



Figure 100. Comparison of value and histogram before and after bringing down midrange values.



Figure 101. Results of bringing down midrange values.

Even though I adjusted the color balance in the image, the sun is still quite saturated and the overall tone of the image is still quite warm. To fix this, I used an adjustment mask to desaturate only the bright values. I wanted to keep the deep darks saturated. Then I ran the image through a cooling photo filter. The result is seen in Figure 102.



Figure 102. Comparison applying cooling filter and desaturation to bright values.

Things are definitely starting to feel a bit more like the light is coming from moonlight streaming in the window. We could call it done, or as we often do in lighting, we could try experimenting. What if we try pushing the value contrast and color even further? Would it break the image or improve it? To experiment, I added a second cooling filter and brought the middle gray values down even further with another curve adjustment. Those changes gave the resulting image in Figure 103.



Figure 103. Comparison pulling middle grays down further and adding a second cooling filter.

Sometimes when looking at an image in comparison with another image, it's easy to see improvements that indicate you've accomplished the DP's note. In lighting it's always a good exercise to go one step further to make sure you've pushed the image as far as you can without breaking it. You'll typically find that you may go a little too far, but the final image leans more towards the pushed version than the original "final" one.

Now the color and light falloff in the image are feeling much more like nighttime. If we really analyze the image however, the window itself still has an overall brightness. It looks like there is a lot of fill light bouncing around outside of the window, much more than we would typically see at night. It does not look like the light source is coming from the moon. Additionally, the sharp value contrast between the bright window and the dark window frame should cause some blooming around the edges of the window.

Painting out some of the bright values on the window by darkening them down enabled me to get the feel of a smaller key source of light outside of the window. To create the impression of bloom, on a separate layer I increased the exposure of the window, blurred it out, and screened it back over the image. These tweaks resulted in the image in Figure 104. The window now feels much more like moonlight is streaming in.



Figure 104. Adjusted time of day image, *The Astronomer*.

IV.5.3. Results



Figure 105. Comparison of original *The Astronomer* to adjusted time of day version of *The Astronomer*.

By understanding the character in our scene, we were able to apply the fundamental of conveying time of day and season in a subtle way, as witnessed in Figure 105. Knowing how important overall key-to-fill ratio, shadow quality, and lighting color are to determining the time of day, we applied the principles to our original image to see what needed to be adapted to give it more of a nighttime feel. We determined that the warm color of the lighting would need to be cooled down and desaturated. Though the value contrast and shadow quality were already close in the original image, by pulling out some of the midlevel grays we made the light appear to fall off faster. This change

began to make the light quality feel more like moonlight. We could have stopped there, but applying a shot lighter's technique of pushing the image a step beyond what you might expect, we pushed the color and value contrast even further. The result was that we ended up with an image that felt even more like a moonlit scene.

Finally, through careful analysis of the light source, we realized that the window needed some adjusting to bring down the amount of bright light spilling in so it felt more like a moon outside the window and less overly filled like day. Adding a little bloom where the bright value of the window overlapped the darks of the windowsill added an extra hint of softness and magic to the scene.

This is also a great example because when we think of night, we often think of it as creating a mysterious and sinister mood. By contrast, in this case, we used night to create a more intimate relationship between our Astronomer and his craft. The cool color as we learned during enhancing mood, atmosphere, and drama, creates a more calm, peaceful feel to the image. With the increased value contrast levels of night, the extra details in the image drop away and our eye is directed to the most important aspects of the image: his face, the globe, and the sky through the window.

CHAPTER V

CONCLUSION

I researched the five fundamentals of lighting design as stated by Sharon Calahan in “Storytelling Through Lighting: A Computer Graphics Perspective” and used the steps in the production lighting process to apply the fundamentals in an original way to famous 2D works of art. The intent was to demonstrate the effects of applying lighting principles developed for 3D computer graphics production to well-known historical 2D paintings in a way that conveys the intended lighting fundamental and creates a distinctly different viewpoint on the image.

Through a thoughtful selection process, I chose a well-known 2D artwork to relight for each of the five fundamentals. After outlining the 3D production lighting critique process from my own experience working as a lighter in the animation industry, I applied this process to each of the images. I created notes for each image as a DP would in a production environment. I applied the notes to the image using my selected tool of *Adobe Photoshop*. Finally, I analyzed the results to be certain that the notes were achieved. The results are 2D images that are easily recognizable as adaptations of the original paintings, but that communicate a distinctly different visual impression.

From the final images and in the results section for each piece, I demonstrated that each original adaptation conveys the intended lighting principle and through lighting alone can change a viewer’s perspective on a famous image. Through the results of this thesis we can conclude that the 3D shot lighting critique process and the fundamentals of

lighting can be applied outside of a 3D lighting environment to 2D paintings creating a distinctly different viewpoint on a well-known work of art. Figures 106-115 show the original images along with the final results for each lighting principle.



Figure 106. Directing the Viewer's Eye – Renoir's *Bal du Moulin de la Galette* – Original.



Figure 107. Directing the Viewer's Eye – Renoir's *Bal du Moulin de la Galette* – Relit.



Figure 108. Creating Depth – Van Gogh's *Bedroom in Arles* – Original.

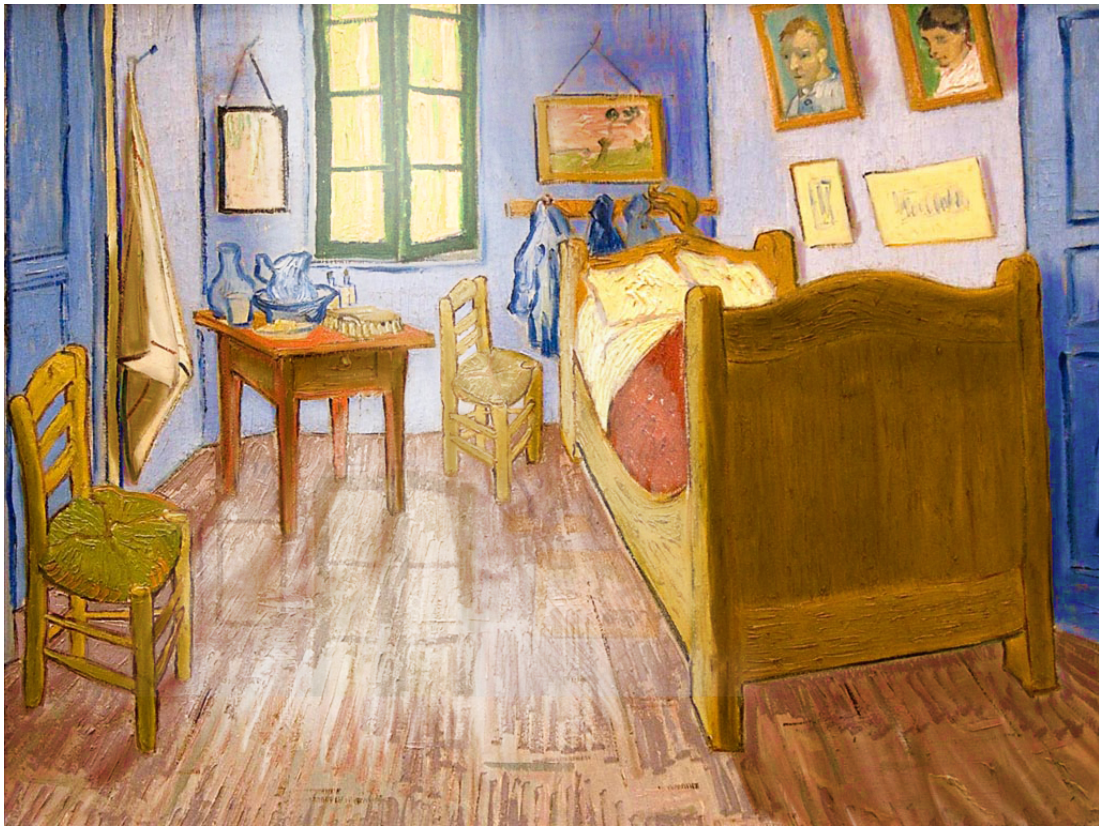


Figure 109. Creating Depth – Van Gogh's *Bedroom in Arles* – Relit.



Figure 110. Enhancing Mood, Atmosphere, and Drama – Degas' *La Classe de Danse* – Original.



Figure 111. Enhancing Mood, Atmosphere, and Drama – Degas' *La Classe de Danse* – Relit.



Figure 112. Revealing Character Personality and Situation – Wood’s *American Gothic* – Original.



Figure 113. Revealing Character Personality and Situation – Wood's *American Gothic* – Relit.

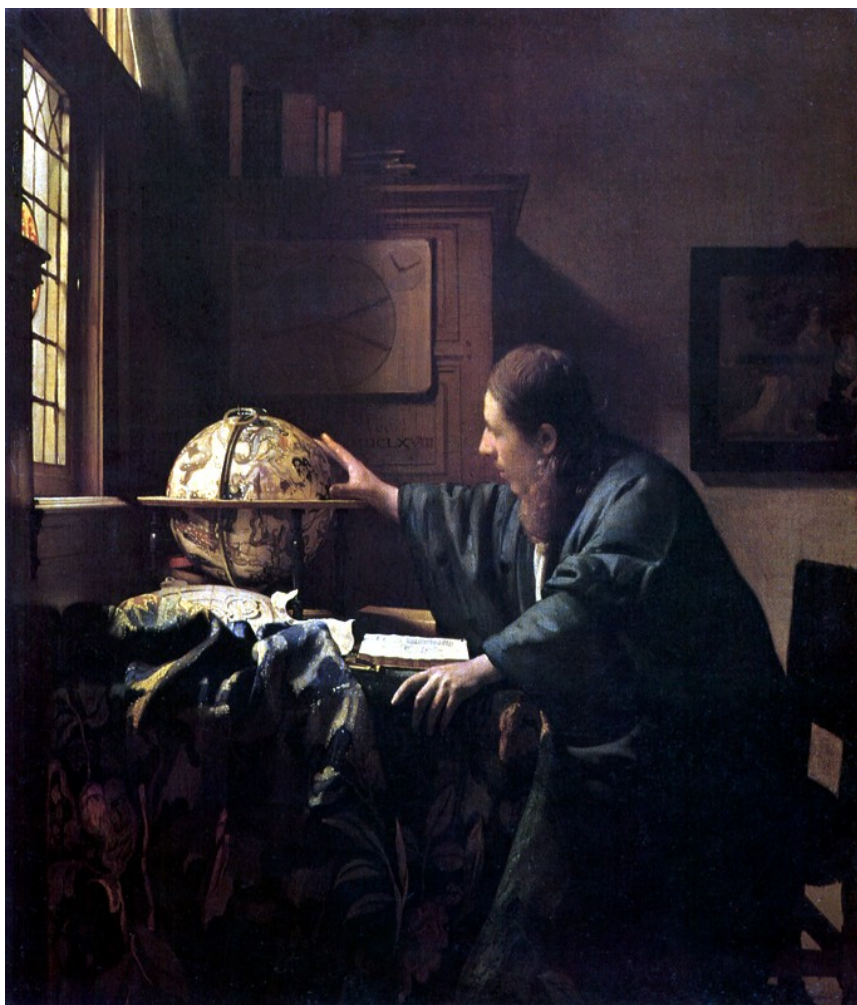


Figure 114. Conveying Time of Day and Season – Vermeer's *The Astronomer* – Original.



Figure 115. Conveying Time of Day and Season – Vermeer's *The Astronomer* – Relit.

CHAPTER VI

FUTURE WORK

There are many ways this research could be developed further and applied to many different pieces created by different artists with different artistic styles. One of the ideas is to use this technique to apply specific artists' lighting styles to other artists' work. In the enhanced mood Degas, applying a technique of increased drama typically associated with artists such as Caravaggio to the high-key style of Impressionism has many applications for interesting research. I would be curious to see the results of an increased dramatic lighting style applied to Surrealism, or more abstractly even to Cubism. Would the lighting style still evoke differences in emotion if applied to a Picasso or a Mondrian? Or is there a point at which art becomes so abstracted that the fundamentals of lighting no longer apply?

This research could also be extended by selecting one 2D piece and taking it through several different viewpoints, for example, to take *American Gothic* and relight it in other ways. It would be interesting to push the limits of the kind of emotions that can be evoked simply by changing the lighting.

For a more technical approach, research could be done to find a way to create meaningful information in the image that was not originally painted in. For example, you'll notice that several of the images I selected for this research are initially bright, low contrast images overall. By starting with brighter images, information about light and form existed throughout the entire image and I was able to create more contrast

through the relighting process. If I were to start out with a darker more contrasting image and try to brighten it up, the darks of the paint have very little information about form that becomes necessary the more light that is shed on the scene. An example is this failed attempt to turn Edward Hopper's famous *Nighthawks* into a daytime scene, Figures 116-117. I was able to lift the darks, but the result loses the smoothness of the brushwork in the original that in my opinion breaks the image.



Figure 116. Edward Hopper's *Nighthawks*.

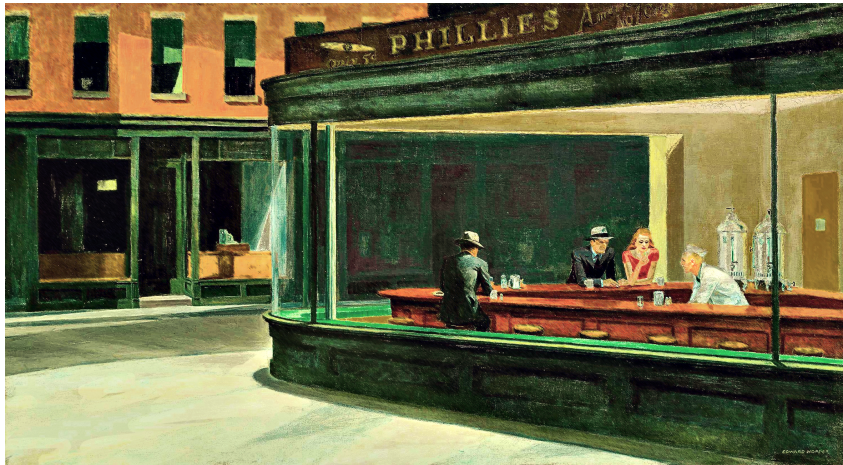


Figure 117. A failed attempt to turn *Nighthawks* into a daytime scene.

REFERENCES

- [1] J. Alton, *Painting With Light*, Berkeley: University of California Press, 1995.
- [2] J. Alton, *The Big Combo*, Dir. Joseph H. Lewis, Allied Artists, 1955, videodisc.
- [3] A. Apodaca, *Advanced Renderman: Creating CGI for Motion Pictures*, San Diego, CA: Academic Press, 2000.
- [4] J. Birn, *Digital Lighting and Rendering*, Indianapolis, IN: New Riders, 2000.
- [5] D. Blauch, "Color," 2009, www.chm.davidson.edu/vce/coordchem/color.html, accessed on April 2012.
- [6] B. Brown, *Cinematography: Theory and Practice: Image Making for Cinematographers, Directors, and Videographers*. Burlington, MA: Elsevier, 2002.
- [7] M. Buonarroti, *The Libyan Sibyl*, painting, 1511, http://en.wikipedia.org/wiki/File:Michelangelo_the_libyan.jpg, accessed May 2012.
- [8] M. Buonarroti, *The Creation of Adam*, painting, 1511, http://en.wikipedia.org/wiki/The_Creation_of_Adam, accessed May 2012.
- [9] S. Calahan, *Ratatouille*, Dir. Brad Bird, Pixar Animation Studios, 2007, videodisc.
- [10] S. Calahan, "Storytelling Through Lighting, A Computer Graphics Perspective," 1996, *SIGGRAPH Course Notes*, www.siggraph.org/education/materials/siggraph_courses/s96_course30.pdf, accessed on May 2012.
- [11] M. Caravaggio, *The Calling of St. Matthew*, painting, 1599, <http://art-lovers-group.buzzsugar.com/Contarelli-Chapel-San-Luigi-dei-Francesi-Rome-Italy-1517450>, accessed May 2012.

- [12] Cimabue, *The Madonna in Majesty*, painting, 1285,
<http://www.artrenewal.org/pages/artwork.php?artworkid=16486>, accessed May 2012.
- [13] L. Da Vinci, *Benois Madonna*, painting, 1478,
<http://atributetoart.com/item.php?id=140>, accessed May 2012.
- [14] R. Deakins, *Rango*, Dir. Gore Verbinski, Paramount Pictures, 2011, videodisc.
- [15] E. Degas, *La Classe de Danse*, painting, 1874,
<http://artchive.com/artchive/d/degas/dancecls.jpg.html>, accessed May 2012.
- [16] M. Douma, curator. "Leonardo da Vinci's Chiaroscuro," *Color Vision & Art*, 2006,
www.webexhibits.org/colorart/anuszkiewicz.html, accessed on April 2012.
- [17] D. Feinberg, *Brave*, Dir. Mark Andrews, Pixar Animation Studios, 2012, videodisc.
- [18] D. Feinberg, *Wall-e*, Dir. Andrew Stanton, Pixar Animation Studios, 2008,
 videodisc.
- [19] R. Freedman. *Universe: Sixth Edition*, New York, NY: W.H. Freeman and Company, 2008, <http://www.whfreeman.com/catalog/static/whf/dtu/>, accessed on April 2012.
- [20] M. Freeman, *The Complete Guide to Light & Lighting in Digital Photography*, New York, NY: Lark Books, A Division of Sterling Publishing Co., Inc., 2007.
- [21] V. Gogh, *Bedroom in Arles*, painting, 1888,
http://en.wikipedia.org/wiki/File:VanGogh_Bedroom_Arles.jpg, accessed May 2012.

- [22] C. Hong, "Lighting Studies: Interpreting Lighting Styles from Traditional Media in Computer-Generated Imagery," M.S. thesis, Texas A&M University, 2002.
- [23] J. Kahrs, "Lighting for Computer Graphics," *SIGGRAPH* Course Notes, 1996, www.siggraph.org/education/materials/siggraph_courses/s96_course30.pdf, accessed on May 2012.
- [24] J. Kalache, *Up*, Dir. Pete Doctor, Pixar Animation Studios, 2009, videodisc.
- [25] J. Lehrer, "Animating a Blockbuster: How Pixar Built *Toy Story 3*," *Wired Magazine*, 2010, http://www.wired.com/magazine/2010/05/process_pixar/all/, accessed on May 2012.
- [26] R. Lowell, *Matters of Light and Depth*, New York, NY: Lowel-Light Manufacturing Inc., 2006.
- [27] J. Morton, "How the Eye Sees Color," *Color Matters*, 2004, www.colormatters.com/color-and-vision/how-the-eye-sees-color, accessed on May 2012.
- [28] L. Pawlik-Klenlen, "Color Psychology: How Colors Affect Mood," 2008, <http://suite101.com/article/the-psychology-of-color-a52964>, accessed on May 2012.
- [29] M. Pidwirny, "Precipitation and Fog," *Fundamentals of Physical Geography, 2nd Edition*, 2006, www.physicalgeography.net/fundamentals/8f.html, accessed on April 2012.
- [30] S. Rangaswamy, "Visual Storytelling through Lighting," 2000, www.gdconf.com/archives/2000/sudeep.doc, accessed on May 2012.

- [31] A. Renoir, *Bal du Moulin de la Galette*, painting, 1876,
http://en.wikipedia.org/wiki/File:Pierre_Auguste_Renoir,_Le_Moulin_de_la_Galette.jpg, accessed May 2012.
- [32] Unknown, “What is Gestalt Psychology?,” *Understanding Media*, 2008,
<http://mediaelectron.blogspot.com/2008/11/what-is-gestalt-psychology.html>,
 accessed April 2012.
- [33] G. Van Honthorst, *The Matchmaker*, painting, 1592,
http://en.wikipedia.org/wiki/File:Gerrit_van_Honthorst_-_De_koppelaarster.jpg,
 accessed May 2012.
- [34] J. Vermeer, *The Astronomer*, painting, 1668,
<http://www.backtoclassics.com/gallery/johannesvermeer/theastronomer/>, accessed
 May 2012.
- [35] K. White, *Toy Story 3*, Dir. Lee Unkrich, Pixar Animation Studios, 2010,
 videodisc.
- [36] J. Wolfe, *Sensation and Perception*, 2nd Edition, Sunderland, MA: Sinauer
 Associates, Inc., 2006.
- [37] G. Wood, *American Gothic*, painting, 1930,
http://en.wikipedia.org/wiki/File:Grant_DeVolson_Wood_-_American_Gothic.jpg,
 accessed May 2012.

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